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PARTICIPATION AND ERROR RATES OF THE INTERNAL REVENUE SERVICE ELECTRONIC FILING SYSTEM: EMPIRICAL EVIDENCE AND IMPLEMENTATION LESSONS

by

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The process of collecting revenue has become increasingly costly for the Internal Revenue Service (ISR) in terms of requirements for storage space and complexity and time involved in converting paper returns into machine readable form. To alleviate these problems, the IRS proposed and developed the Electronic Filing System (EFS) which provides taxpayers the option of filing tax returns electronically. This study consists of a two year field study of the EFS in the IRS San Jose District with respect to the reasons for success or failure of the implementation of computer systems, with particular emphasis on the participation rate and the error rate. The study includes a statistical analysis of responses to two surveys distributed by the San Jose District EFS Office to determine whether there is significant evidence to indicate reasons why some users have higher error rates than others. A case study approach is used, in conjunction with available literature, to determine factors which influence the effective implementation of an information system and encourage use of the system.

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Participation and Error Rates of the
Internal Revenue Service Electronic Filing System:
Empirical Evidence and Implementation Lessons

by

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ABSTRACT

The process of collecting revenue has become increasingly costly for the Internal Revenue Service (IRS) in terms of requirements for storage space and the complexity and time involved in converting paper returns into machine readable form. To alleviate these problems, the IRS proposed and developed the Electronic Filing System (EFS) which provides taxpayers the option of filing tax returns electronically. This study consists of a two year field study of the EFS in the San Jose District with respect to the reasons for success or failure of the implementation of computer systems, with particular emphasis on the participation rate and the error rate. The study includes a statistical analysis of responses to two surveys distributed by the San Jose District EFS Office to determine whether there is significant evidence to indicate reasons why some users have higher error rates than others. A case study approach is used, in conjunction with available literature, to determine factors which influence the effective implementation of an information system and encourage use of the system.

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I. INTRODUCTION

A. BACKGROUND

The process of collecting revenue has become increasingly costly for the Internal Revenue Service (IRS). The increasing number of returns processed each year has resulted in continually increasing need for storage space. In addition, the process of converting paper returns into machine readable form has become more complex, time-consuming and error-prone. [Ref. 1]

To alleviate these problems, the IRS proposed and developed a system for the electronic filing of tax returns. The IRS electronic filing pilot program was initiated in 1986. The program has expanded each year since and is currently available in all 50 states.

B. OBJECTIVES AND RESEARCH QUESTIONS

The San Jose District Electronic Filing Coordinator has expressed interest in increasing the participation rate for the area served by his office and reducing the current error rate. The San Jose District of the IRS has participated in the Electronic Filing System (EFS) since 1988. This study considers possible explanations for the existing rates and explores potential methods and approaches to increase the participation rate and lower the error rate.

Specifically, the questions addressed are:

1. Why do some filers have very low error rates while others have high error rates?

2. How can the participation rate be increased?

3. How can the error rate be reduced?

4. What are the lessons learned to successfully implement a large scale computer application?

C. SCOPE

The study consists of a two year field study of the EFS in the San Jose District with respect to the reasons for success or failure of the implementation of computer systems. Particular areas of emphasis are the participation rate and the error rate. Recommendations on increasing the participation rate and lowering the error rate are proposed.

D. METHODOLOGY

The San Jose District EFS Office distributed surveys to all tax practitioners accepted into the EFS program following the 1989 and 1990 filing seasons. The study statistically analyzes responses to the two surveys to determine whe' ' there is significant evidence to indicate reasons why some users have higher error rates than others.

Consideration of the participation rate includes an examination of the comments provided by tax practitioners on the surveys. A case study approach is used, in conjunction with available literature, to determine factors which influence the effective implementation of an information system and encourage use of the system.

E. ORGANIZATION OF STUDY

This study is discussed in detail in the following pages. Chapter II provides a review of the applicable literature. Chapter III includes a history of EFS and a discussion of the EFS concept and components. Chapter IV provides a definition of the problem to be examined, describes the survey data and summarizes the statistical analysis methodology and results with regard to the error rate for filers. The implementation of EFS as a case study of implementation of end-user computing systems is discussed in Chapter V. Chapter VI includes a discussion of the findings of the study and recommendations for lowering the error rate and increasing the participation rate.

II. LITERATURE REVIEW

A. OVERVIEW OF LITERATURE

The literature reviewed for this study falls into three general categories: (1) implementation of computing systems, (2) end-user computing, and (3) the use of case studies in MIS research. Some of the literature overlaps categories (1) and (2) because it directly addresses implementation of end-user computing systems.

While there is an abundance of literature on implementation of information systems in organizations, its applicability to this study is not definitive because of the unique environment in which EFS operates. It is a system with users in many different organizations; its structure does not conform to any other organizational structure. The application of literature in the first category is used, therefore, with the understanding that it does not directly reflect the EFS environment. Literature in the second category, end-user computing, offers different definitions/categorizations of end-users. It examines success factors in end-user computing which are useful in discerning factors which influence successful acceptance of and participation in EFS. The third category, the use of case studies in MIS research, provides support for use of a case study, such as that employed in this study, to perform MIS research.

B. IMPLEMENTATION LITERATURE

1. Lewin-Schein and Kolb-Frohman Models

Implementation of a management information system involves changes in the organization in which the system is implemented, just as the introduction of any new technology or practice results in change. Numerous models of change have been proposed; among them are the Lewin-Schein theory of change and the Kolb-Frohman model [Ref. 2:p. 65].

The Lewin-Schein model divides the change process into three sequential stages--unfreezing, moving and refreezing. The unfreezing stage includes "...activities that help members of an organization to free themselves from the patterns of behavior and mind-sets in existence prior to the introduction of change." [Ref. 2:p. 65] In the moving stage, organization members learn new behavior. The final stage, refreezing, makes the new behavior patterns permanent.

The Kolb-Frohman model operationalized the Lewin-Schein model, mapping seven stages onto its three. In the Kolb-Frohman model, the scouting, entry and diagnosis stages correspond to Lewin-Schein's unfreezing stage. The moving stage is divided into two--planning and action--in the Kolb-Frohman model, while the evaluation stage overlaps the moving and refreezing stages. Kolb-Frohman's final stage, termination, corresponds to the refreezing stage.

2. Factors Affecting Implementation

The process of implementation is a complex one which must consider the organizational, behavioral and environmental as well as the technological facets involved in the design, development and operation of information systems within organizations [Refs. 3, 4, 5, 6]. According to Ginzberg and Schultz, implementation is dynamic in nature as evidenced by the constant changes in the implementation environment, technology, and approaches to implementation [Ref. 3:p. 2]. Rivard emphasizes the importance of planning to implementation, asserting that successful implementation requires careful planning in the determination of users' requirements and the development of criteria, methods and procedures for evaluation [Ref. 4:p. 33]. In discussing the reasons information systems fail, Lucas lists three problem areas in system design and implementation: technical, organizational and project management [Ref. 6:p. 4]. He states that, "Concentration on the technical aspects of systems and a tendency to overlook organizational behavior problems and users are the reasons most information systems have failed." [Ref. 6:p. 2]

The significance of organizational behavior to the success or failure of implementation of information systems recurs often in the literature [Refs. 6, 7, 8, 9]. According to Lucas, "...the major reason most information systems have failed is that we have ignored organizational behavior problems in the design and operation of computer based information systems." [Ref. 6:p. 6] He states that organizational behavior variables must be considered if systems are going to be designed and operated successfully [Ref. 6:p. 106]. Desanctis and Courtney also emphasize the significant role of organizational

behavior in implementation and propose merging organizational development techniques into MIS implementation [Ref. 8:p. 733].

3. User Participation and Attitude

User participation in system development and operation and users' attitudes toward the system are other areas of importance discussed in the literature [Refs. 6, 8, 10]. Baroudi, Olson, and Ives' study demonstrates that user involvement in the development of an information system positively correlates with system usage [Ref. 10:p. 236]. Lucas states that user participation in design considerations is essential. The user should be the source of the systems and design them wherever possible, delineating decisions and user actions as well as flow of information and documents. [Ref. 6:p. 111] Lucas asserts that user involvement in design and operation results in favorable user attitudes and perceptions which lead to high levels of use. [Ref. 6:pp. 22-23] Desanctis and Courtney also stress the importance of user attitude. They state that, "...implementation research suggests that it is not enough that the technology be friendly to the user. The user must also be friendly to the system." [Ref. 8:p. 732]

4. Implementation Process

The process used to implement an information system has a significant effect on the system's success or failure [Refs. 2, 11, 12]. Srinivasan and Davis state that,

> The advent of powerful new technologies coupled with an array of diverse user types has resulted in system usage patterns that the process models are unable to capture. An alternative perspective focuses on the user and user roles, the mechanisms that exist for the facilitation and support of users, and the nature of learning that has occurred in the system environments of organizations. [Ref. 2:p. 64]

According to Srinivasan and Davis, process models such as the Lewin-Schein and the Kolb-Frohman models are based on assumptions which may no longer be valid. These models assume that implementors act as change agents and that user groups are homogeneous and somewhat resistant to change. In contrast, Srinivasan and Davis suggest that implementors are now facilitators and coaches to a heterogenous group of users, a good proportion of which are not resistant to the introduction of information systems. [Ref. 8:p. 67]

Receptiveness to innovations is an important consideration when developing a process for implementation. Leonard-Barton, in discussing the subject of resistance to and acceptance of innovation, states that innovations rarely meet with immediate acceptance. In a study of the introduction of structured software methodologies, Leonard-Barton emphasized that implementation managers must build positive influences and counter negative ones to facilitate acceptance of innovations within an organization. [Ref. 12:p. 6]

C. END-USER COMPUTING LITERATURE

The literature reviewed on the subject of end-use: ' mputing can be divided into two subcategories: (1) definition/classification of end-users and (2) successful implementation of and user satisfaction with end-user computing systems. Applicability of literature in the second category is influenced by the authors' conceptualizations of the end-user. The data and insights provided by the authors are, therefore, not applicable to all end users. [Ref. 13:p. 1313]

1. Definitions of End-Users

Definitions of end-users vary from general to very specific. The more specific ones, such as the definitions of Rockart and Flannery [Ref. 14] and Cotterman and Kumar [Ref. 13], recognize that degree of involvement with a system throughout its life cycle, as well as interaction with the operational system, is important to a meaningful definition/classification of an end-user.

Doll and Torkzadeh's and Davis and Olson's definitions are among the more general ones [Ref. 15]. Doll and Torkzadeh define end-users as "...individuals who interact directly with the computer." [Ref. 15:p. 261] Davis and Olson distinguish between primary and secondary users. Primary users make decisions based on the system's output while secondary users interact with the application to enter information or prepare reports. Secondary users do not use system output directly. [Ref. 15:p. 261]

The CODASYL end-user facilities committee identifies three classes of end-users. Indirect end-users use computers through other people. Intermediate end-users specify information requirements for reports which they receive. Direct end-users use the computer terminals. [Refs. 13, 15] Rockart and Flannery further refine the CODASYL classification into six classes of end-users [Ref. 14].

Cotterman and Kumar examine numerous definitions/classifications of end-users with the objective of developing "...a precise and comprehensive definition and taxonomy of end users." [Ref. 13:p. 1313] They define end-user and end-user computing as follows:

> An end user is any organizational unit or person who has an interaction with the computer-based information system as a consumer or producer/consumer of information. End user computing is the producer activities of the end users relative to the organization's computer-based information system. [Ref. 13:p. 1315]

Cotterman and Kumar identify three dimensions in the classification of end-users: operation, development, and control. The operation dimension involves actual hands-on operation of the system hardware and software. The development dimension includes the performance of tasks related to system development. The control dimension consists of the "...decision-making authority to acquire, deploy, and use the resources needed to develop and operate [the system]." [Ref. 13:p. 1315] These three dimensions can be superimposed on a cube (Figure 1) which can be used to classify end-users according to the degree of their involvement with each of the dimensions. Applying the CODASYL classifications to the user cube, for example, would result in locating the indirect user at (0,0,0); the intermediate user between (0,0,0) and (0,1,0), depending on extent of involvement with development effort; and the direct user between (0,0,0) and (1,0,0). [Ref. 13:pp. 1315-1316]

2. Implementation Success Factors and User Satisfaction in End-User Computing Systems

Success factors offered in the literature are numerous and varied. Rockart and Flannery cite the need for brief, example-based education for end-users who desire to learn only as much as they need to know to perform the tasks which are important to them as one factor in the successful implementation of end-user computing systems [Ref.14:p. 783]. Doll and Torkzadeh state that ease of use, content (information

contained in the system), accuracy, format, and timeliness are among the components which determine end-user satisfaction [Ref. 15:p. 268].

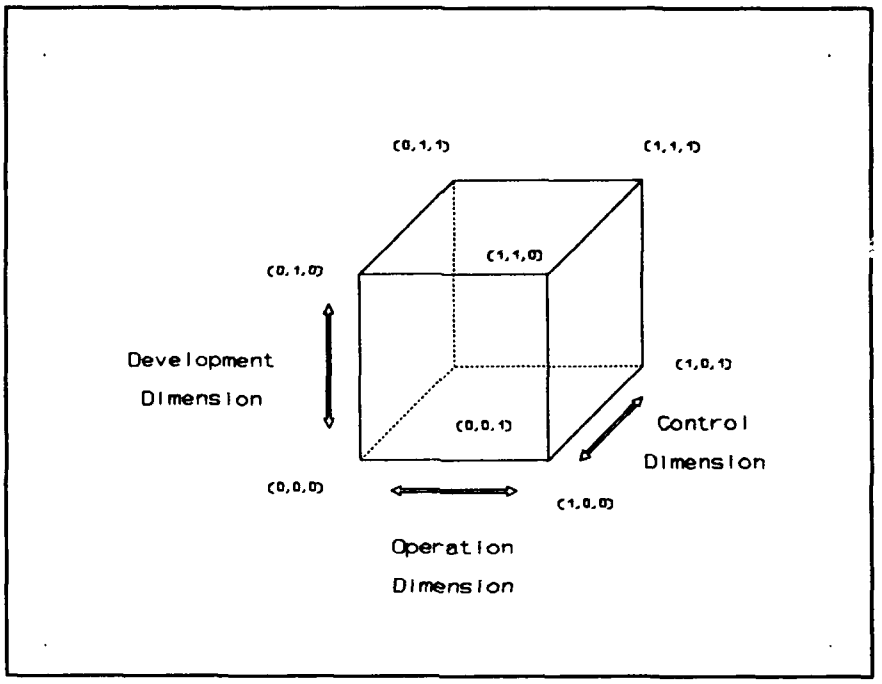


Figure 1. User Cube [Ref. 13:p. 1316]

Rivard and Huff propose several success factors for end-user computing in a study of user development of computer-based applications within an organization. Among the factors they found to have an effect are: (1) perceived user friendliness, (2) positive user attitude, (3) computer background of the user, and (4) organizational support.Overall satisfaction was most closely related to the support provided by the Data Processing Department of the organization. [Ref. 16:pp. 553-558]

Rivard states that contributors to user satisfaction in organizations fall into two groups: (1) technological factors and (2) organizational factors. The technological factors

are user friendliness of the software tools, environmental conditions, and support provided to users. Elements of user friendliness include a requirement that the user learn only a few new concepts and key words to start; meaningful, helpful error messages; and high quality user's manual. Organizational factors consist of Information Systems (IS) management's readiness for change, users' attitude toward end-user computing, and users' independence from the IS department. [Ref. 4:pp. 26-27]

D. MIS CASE STUDY LITERATURE

MIS research does not readily conform to the traditional techniques of quantitative analysis. The literature reviewed supports the use of case study research as a viable alternative. [Refs. 17, 18] A "case study" is described by Benbasat, Goldstein and Mead as follows:

> A case study examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or a few entities....The boundaries of the phenomenon are not clearly evident at the outset of the research and no experimental control or manipulation is used. [Ref. 17:p. 370]

They cite several reasons for dissatisfaction with MIS research information obtained through quantitative techniques. The complexity of multivariate research methods and the distribution restrictions inherent in the use of these methods (the requirement for distributional normality) are two of the reasons. Others are the large sample sizes which the methods dictate and the difficulty interpreting the results of studies in which these methods are used. [Ref. 17:p. 369] Because information systems are in a state of constant technological change and innovation, researchers can best learn by studying innovations of practitioners to form the basis for the development of prescriptive guidelines. [Ref.

17:p. 370] Case study research is a viable information system research strategy because: (1) the researcher can study the IS in a natural setting and generate theories from practice, (2) the researcher can understand the nature and complexity of the processes involved, and (3) it is an appropriate way to research an area of which few studies have been done. [Ref. 17:p. 370]

Lee also supports the use of case studies as a methodology of MIS research. Using the standards of the natural science model for testing theories, he cites four problems when conducting MIS research as a case study and responds to each. First, it is difficult to make controlled observations in an MIS study. Lee suggests using natural controls existing in the environment under study. Second, making controlled deductions is complicated by the usually qualitative nature of the data. His response is that, because mathematics is a subset of formal logic, qualitative predictions are therefore logically valid and acceptable in lieu of quantitative predictions. Third, the researcher cannot replicate a sequence of events to verify his findings. Lee states that, although observations cannot be precisely replicated, findings can be. Fourth, the unique events in the study of a case make it difficult or impossible to extend findings to other settings. To resolve this problem of generalizability, a theory must have been tested and confirmed in a variety of situations before being generalized. [Ref. 18:pp. 35-40]

E. SUMMARY

Table 1 summarizes the literature reviewed for this study.

Key Issue	Reference
Lewin-Schein Model	Srinivasan/Davis [Ref. 2]
Kolb-Frohman Model	Srinivasan/Davis [Ref. 2]
Effect of Organizational Factors	Lucas [Ref. 6] Lyytinen [Ref. 7] Desanctis/Courtney [Ref. 8] Markus [Ref. 9]
Effect of Planning	Rivard [Ref. 4]
Dynamic Nature of Implementation	Ginzberg/Schultz [Ref. 3]
Reasons for IS Failure	Lucas [Ref. 6]
Effect of User Participation	Baroudi/Olson/Ives [Ref. 10] Lucas [Ref. 6]
Effect of User Attitude	Lucas [Ref. 6] Desanctis/Courtney [Ref. 8]
Implementation Process Models	Srinivasan/Davis [Ref. 2] Leonard-Barton [Ref. 12]
Receptiveness to Innovation	Leonard-Barton [Ref. 12]
Classification of End-Users	Rockart/Flannery [Ref. 14] Cotterman/Kumar [Ref. 13] Doll/Torkzadeh [Ref.15]
User Cube	Cotterman/Kumar [Ref. 13]
Implementation Success Factors	Rockart/Flannery [Ref. 14] Doll/Torkzadeh [Ref. 15] Rivard/Huff [Ref. 16] Rivard [Ref. 4]
MIS Case Study Research	Benbas 'Goldstein/Mead [Re ' 17] Lee [Ref. 18]

Table 1. Summary of Literature Review

III. OVERVIEW OF THE ELECTRONIC FILING SYSTEM

A. HISTORY

The IRS has experienced a trend toward increasing numbers of paper returns and accompanying documentation received for processing at its service centers. The result has been concomitant increases in costs for storage space, processing and personnel to handle the volumes of paper. In an effort to control costs and make the processing of tax returns more efficient, the IRS has developed a system which provides for the electronic filing of returns.

In 1986, the IRS Research Division introduced a pilot Electronic Filing System (EFS) program in three metropolitan areas of Ohio, North Carolina and Arizona. Participants in the program filed 25,000 Individual Federal Income Tax Returns. The system was considered a success and became operational in 1987. [Ref.1]

In each subsequent year the program expanded to include more participants in a wider geographic area, more forms and schedules which could be filed electronically, and more returns filed using EFS. The IRS introduced electronic filing of Business Returns as a pilot program in 1987 and electronic filing of Employee Plans Returns in 1988. In 1989 the EFS office assumed direction of both these programs from the Research Division. The 1990 filing season was the first in which all 50 states were able to participate. Electronic filing of balance due returns was introduced in 1991 in ten states. [Ref. 1]

The San Jose District became part of the system in 1988. Returns filed in the first year totalled 10,600; in the second year, 17,900 returns were filed. In 1990, 38,000 returns were filed electronically in the San Jose District, an increase of more than 100 percent over 1989. Electronically filed returns accounted for 4.7 percent of the total number of returns requiring refunds. [Ref. 19]

B. TERMINOLOGY

Two different references to time periods are used in this study. "Tax year" refers to the calendar year for which income tax is paid or withheld. For example, the 1989 tax year is January 1,1989, to December 31, 1989. "Filing season" refers to the period during which tax returns are filed, normally January to April 15 of one year. For example, the 1990 filing season refers to the period of time between January 1990 and April 15, 1990, when returns for tax year 1989 are filed.

The different types of electronic filers are defined as follows. (All are considered "tax practitioners.") A "preparer" fills in the electronic return and computes the tax based on information the taxpayer provides. A "transmitter" transmits returns directly to the IRS. A "preparer/transmitter" performs the same role as a preparer and also transmits the return directly to the IRS. A "service bureau" is a tax return processor who provides a variety of services, including collection or transmittal of returns to the IRS. An "electronic return collector" accepts prepared returns directly from taxpayers from which it produces electronic returns. [Ref. 20:p. 8] A comprehensive glossary of terms and acronyms used in this paper is contained in Appendix A.

C. EFS CONCEPT

1. Definition of Electronic Filing

Electronic Filing (EF) is defined by the IRS as "...the receipt and processing of tax returns using electronic records." [Ref. 21:pp. 1-2] EF is designed to offer advantages to taxpayers, tax practitioners, and the IRS. Taxpayers should benefit from faster processing of returns and, therefore, faster receipt of refunds. Tax practitioners who offer the service should have a competitive advantage over those who do not. The IRS should benefit from reduced costs for processing, storage and retrieval of tax returns. [Ref. 22]

In addition to requiring less time to process, electronic returns have a higher accuracy rate than paper returns. The error rate for electronic returns filed during the 1989 filing season was approximately three percent, while paper returns averaged about 16 percent. The IRS attributes the lower error rate for electronic returns to the electronic filing software which verifies the accuracy of the returns before transmission. [Ref. 20] Figure 2 compares paper and electronic return processing.

2. Process Overview

The procedure for filing electronically is as follows. A tax preparer or transmitter desiring to use EFS applies for admission into the program. The IRS performs a suitability check of the applicant to determine whether the applicant has a history of Internal Revenue Code violations or other problems with the IRS which cast doubt on the integrity or ability of the applicant to participate in the EFS program.

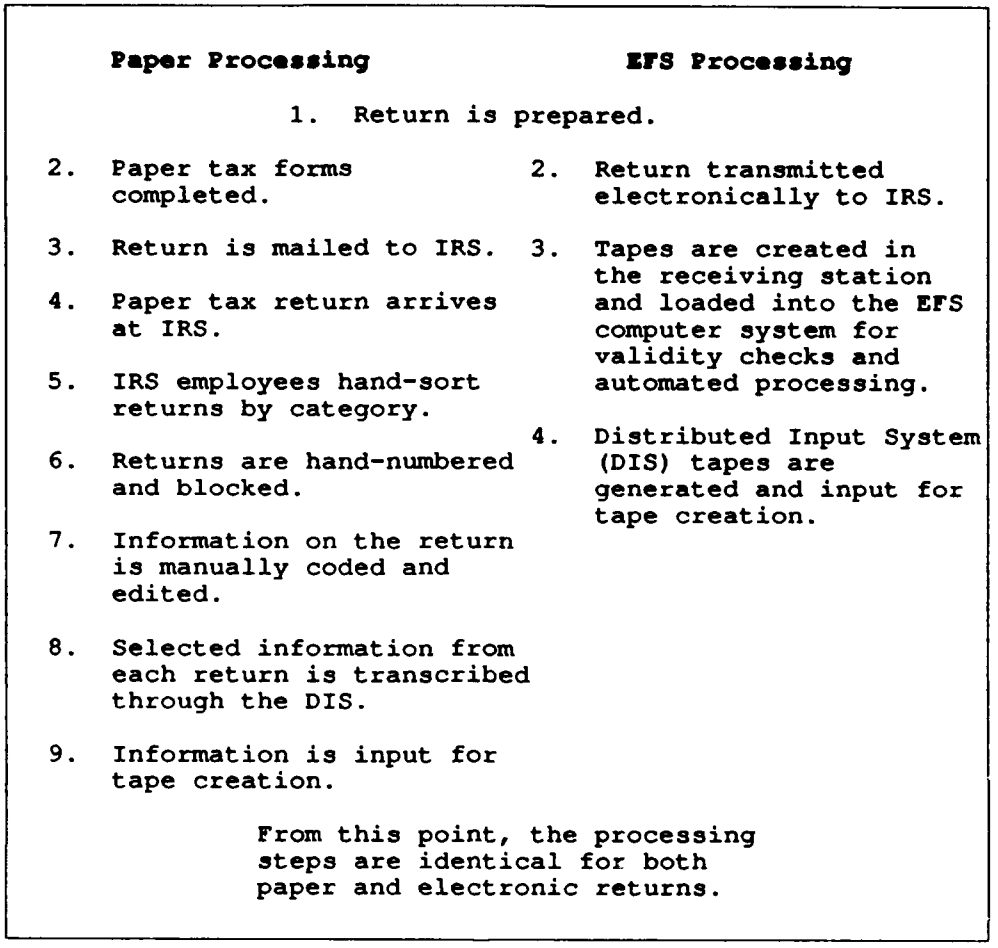


Figure 2. Comparison of Paper and Electronic Tax Processing [Ref. 20]

Following the suitability check, applicants are assigned an Electronic Filer Identification Number (EFIN). Software developers and direct transmitters must successfully complete acceptance testing before being accepted into the program. [Ref. 20]

Return data is processed by the IRS and, if valid, an acknowledgement file is sent to the transmitter. The return data is formatted and merged with paper return data on tape for the release of refunds. Error free returns are archived to optical disk. Returns

requiring corrections are temporarily stored on disk from which tax examiners make corrections on a shadow page of the return. [Ref. 21]

Electronic returns are processed at one of three service centers whose areas of responsibility are geographically determined. The Andover Service Center in Massachusetts serves the Northeast and Middle Atlantic states. The Cincinnati Service Center in Ohio serves the South and eastern part of the Midwest. The Ogden Service Center in Utah serves the western part of the Midwest and the West. District Offices processed by a Service Center are responsible for coordinating the EFS program within their assigned area, providing training to and interfacing directly with users. [Ref. 20]

3. EFS Components

The Electronic Filing System in each Service Center consists of three subsystems: the Data Communications Subsystem, the Processing Subsystem, and the Archival/Retrieval Subsystem. [Ref. 21] The functions of the subsystems are described in the following paragraphs.

The Data Communications Subsystem includes both dial-up and leased (dedicated) modems. Electronic returns are transmitted via modem to an IBM Series/1 communications processor which receives the tax data and stores it to a uniquely named disk file. [Ref. 21]

The Processing Subsystem is composed of a UNISYS 1180 mainframe computer and software which formulate and validate the information received by the Data Communication Subsystem. This subsystem processes the electronically filed tax data to mesh with key entered tax data. [Ref. 21]

The Archival/Retrieval subsystem consists of a Network Server (File Manager), an Optical Disk Manager, several Forms Processing Workstations, and a Print Subsystem. The Network Server is comprised of both disk and tape drives. The server stores all active returns and assigns and prioritizes work for tax examiners who make adjustments to the returns. The Optical Disk Manager transfers error-free returns to optical disk for long-term storage. Forms Processing Workstations are personal computers on which tax examiners check and make corrections to a shadow page of an electronic return. The Print Subsystem consists of laser printers which provide the capability to print paper copies of electronically filed returns if necessary. [Ref. 21]

IV. SURVEY DATA AND STATISTICAL ANALYSIS

A. DESCRIPTION OF DATA

The data which was used in this analysis was published in two forms by the IRS. Data on the number of returns submitted, accepted and rejected; the refund amount; and the percentage of rejected returns for each filer in the San Jose district was contained in the Electronic Filing Report produced by the Ogden Service Center. Additional data was available from surveys which the district EFS Coordinator mailed to all individuals or firms which had EFINs. Two surveys were used: one which addressed the 1989 filing season and one which addressed the 1990 filing season.

1. Electronic Filing Report

The Electronic Filing Report is produced and distributed weekly during the filing season and lists year-to-date filing statistics on electronic filers in the San Jose district. It is arranged in columnar format and includes the following information for each individual or firm which filed at least one return electronically during the 1990 filing season: EFIN, Originator Name, Transactions (Returns), Acceptances, Rejections, Duplicate Returns, Expected Refund Amount, and Percentage of Rejected Transactions.

The EFIN, Transactions, Expected Refund Amount and Rejection Percentage were used in the statistical analysis for this study. The Originator Name, in combination with the EFIN, was used to link the data from the report to the information obtained from the surveys.

The EFIN is a six digit code number which uniquely identifies each electronic filer. The first two digits of each EFIN are "77" which is the code for the San Jose District. Once assigned, the individual or firm uses the same EFIN from year to year. Transactions are the year-to-date total of the number of returns filed electronically under an EFIN. Expected Refund Amount is the year-to-date total amount of the refunds for returns filed electronically under an EFIN. Rejection Percentage is the quotient of the number of returns rejected divided by the total number of returns filed electronically.

2. Surveys

The format of the two surveys was similar, but the questions asked on each were different. Questions generally required either a positive response, if the question applied to the filer, or no response. Comments were solicited for most questions. The questionnaires are reproduced in Appendix B.

B. SELECTION OF SUBJECTS

1. Subject Selection Method

Subjects for each of the two surveys included all firms and individuals in the San Jose district who held an EFIN during the filing season corresponding to the survey year. Subjects for the Electronic Filing report included all firms or individuals in the San Jose district who filed at least one return electronically during the 1990 filing season. The subject pool for the Electronic Filing report was, therefore, a subset of the subject pool for the 1990 survey.

2. Geographical Distribution of Sample

The sample data which was collected and analyzed for this study was drawn from the geographic area of responsibility of the San Jose district office of the IRS. The San Jose district is responsible for an area of central California bounded by Menlo Park on the northwest, Mono Lake on the northeast, Edwards Air Force Base on the southeast and Port Hueneme on the southwest.

C. SURVEY RESPONSE RATE

The 1989 survey questionnaire was mailed to 450 Electronic Filing tax preparers who were accepted into the program for the 1989 filing season. There were 234 responses as of July 27, 1989, a 52 percent response rate. The 1990 survey questionnaire was mailed to 650 Electronic Filing tax preparers who were accepted into the program for the 1990 filing season. There were 373 responses as of July 20, 1990, a 57 percent response rate.

D. IRS SUMMARY OF SURVEY RESPONSES

Summaries of the responses to the 1989 and 1990 surveys are reproduced in Appendix B. The San Jose district EFS Coordinator produced the summaries. The IRS analysis of the data included a listing of the comments that survey respondents made to each question, in addition to the response summaries. The 1990 survey report also included a summary of the reasons respondents cited for not using electronic filing during the 1990 filing season.

E. STUDY ANALYSIS

1. Problem Definition

Two problems are addressed in this study: the high error rate for some electronic filers and the low participation rate in EFS in the San Jose District. Both problems can be considered symptomatic of the degree of success of the implementation of electronic filing by the IRS.

The reason for the differences in error rate among filers is not readily discernable. Experience level of filers varies, as well as the software and transmission methods they use. The participation rate can be affected by many factors. The multiplicity of stakeholders who are also users of the system complicates the examination of factors influencing participation. These stakeholders include taxpayers, tax preparers, third party transmitters, and electronic filing technicians at the IRS. The interests and priorities of each group of stakeholders are different and, while not necessarily conflicting, make determination of an effective strategy of implementation a complex issue. Statistical analysis was used to investigate possible reasons for differences in filers' error rates and is discussed in Section 3 below.

The implementation of EFS is unique in that it is not used within a single organization. It was implemented by the IRS to be used by the IRS itself and by organizations independent of the IRS. Use of EFS by tax practitioners is voluntary; support may be provided to users from within their own organizations as well as from the IRS. The participation rate is discussed in Chapter V using a case study approach.

2. Discussion of Survey Responses

Examination of the responses to the 1989 and 1990 IRS surveys revealed that problem areas reported by respondents were different in 1989 than in 1990. Direct comparison of all categories is not possible because different questions were asked on the two surveys. Figure 3 graphs the number of respondents reporting problems in four areas in 1989. Problems with transmitter were most often noted. Figure 4 graphs the reported problems in 1990. Software problems were most often reported, followed by cost.

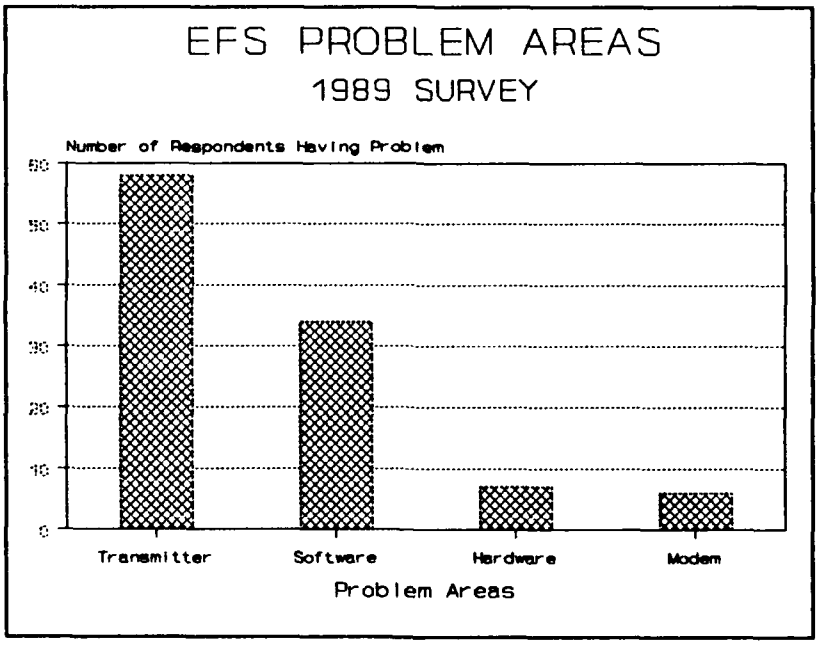


Figure 3. Problem Areas--1989

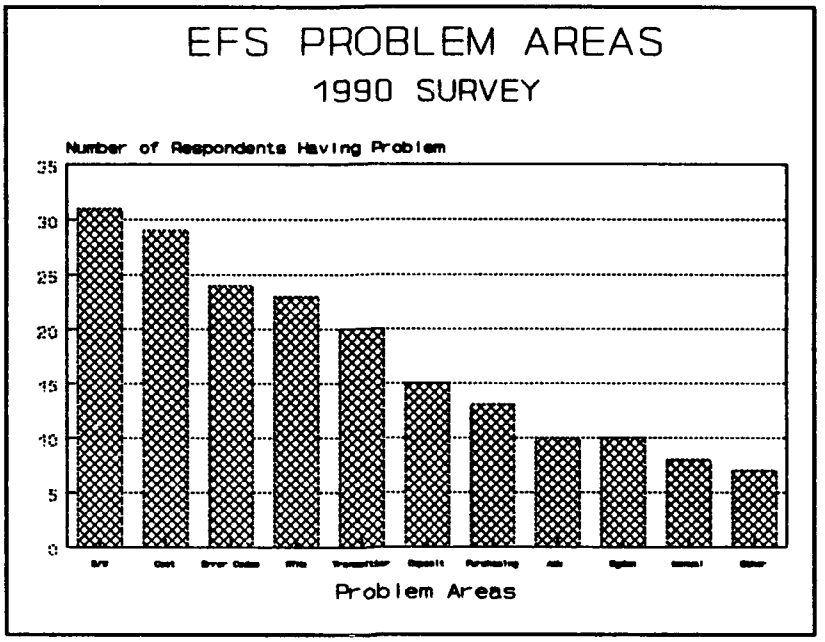


Figure 4. Problem Areas--1990

Figure 5 compares 1989 and 1990 responses in the areas of transmitter and software problems, the only two problem areas addressed in both surveys. In 1989, 24 percent of respondents reported problems with transmitters compared with six percent in 1990. Software problems were reported by 14 percent of respondents in 1989 and by 10 percent in 1990. In general, proportionately fewer respo...ents had problems with either transmitters or software in 1990. This decrease may be attributed to increasing familiarity of users with the system or to improvements made in the transmitters and the software.

The surveys yielded information on individual transmitters with which respondents had trouble. Figure 6 shows the three most trouble prone transmitters in 1989 were Unitax, ELF, and Compucraft. In 1990, as shown in Figure 7, Lacerte,

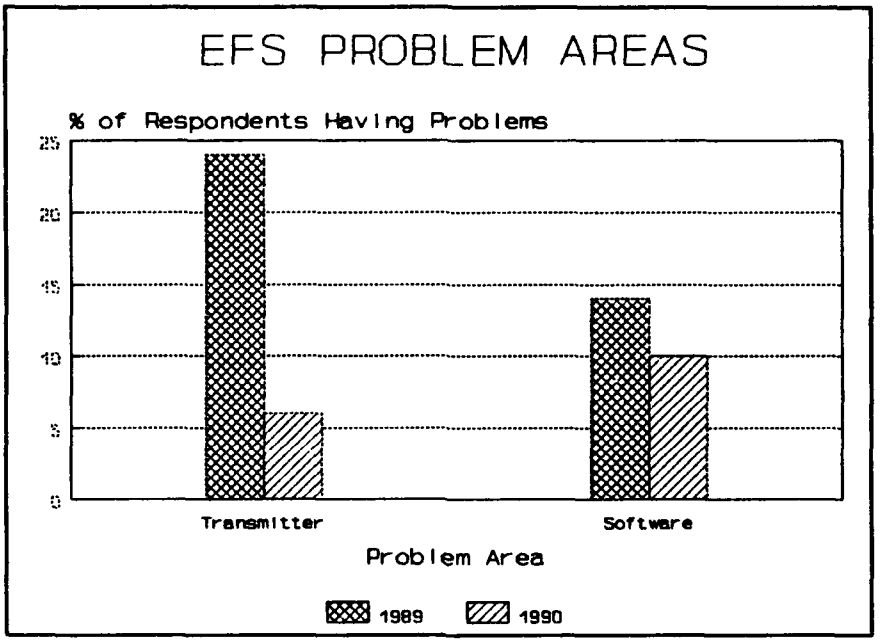


Figure 5. Problem Areas--1989 and 1990

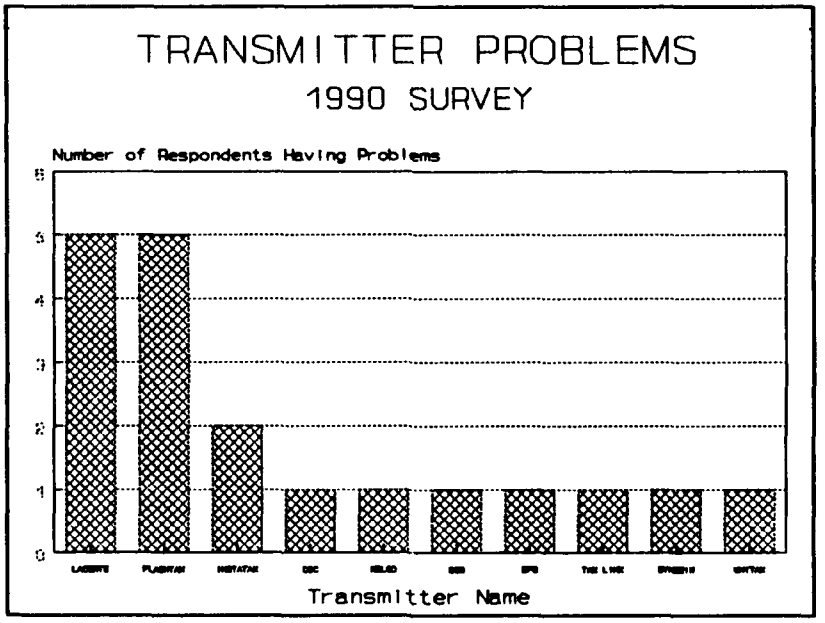


Figure 6. Transmitter Problems--1989

Flashtax, and Instatax were most often reported by respondents as causing problems. (Lacerte contracted electronic filing to Flashtax in 1990; problems survey respondents reported with Lacerte, therefore, may have been related to the Flashtax transmitter.) No transmitter can be singled out as causing significant problems in both 1989 and 1990. (It should be noted that the survey data is historic and the analysis does not predict the quality of future performance of any transmitter.)

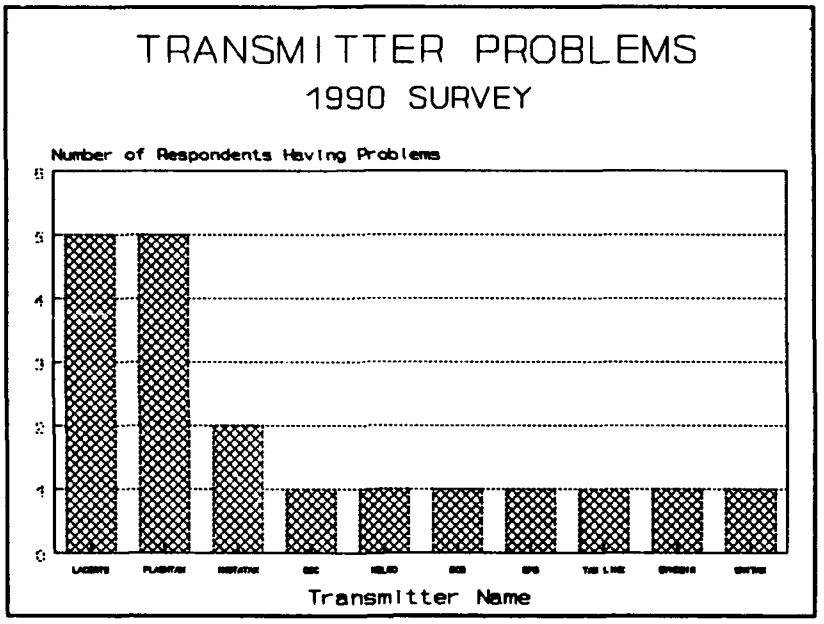


Figure 7. Transmitter Problems--1990

As a transmitter, Compucraft improved its position considerably between 1989 and 1990, earning not one complaint in 1990 and, as shown in Figure 8, was the most widely used and most highly recommended transmitter in the 1990 survey. Flashtax and Lacerte were the next most widely used transmitters but received "Not recommended" responses from a majority of their users. (Lacerte contracted electronic filing to Flashtax

in 1990; problems survey respondents reported with Lacerte, therefore, may have been related to the Flashtax transmitter.)

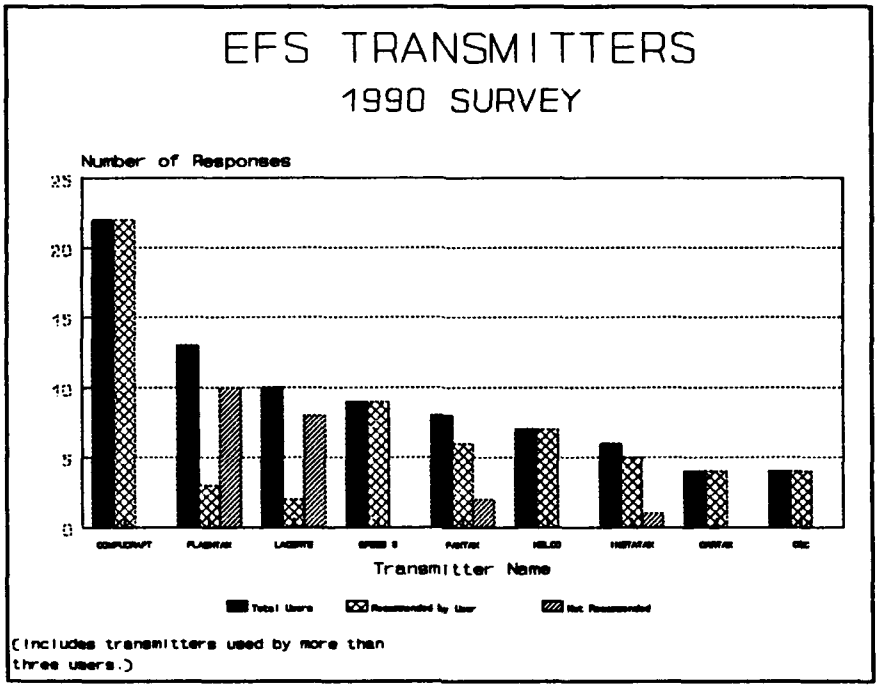


Figure 8. Transmitter Recommendations--1990

Software problems reported on the two surveys are graphed in Figures 9 and 10. In both 1989 and 1990, more respondents reported problems with Lacerte than with any other software. (It should be noted that the survey data is historic and the analysis does not predict the quality of future performance of any software.)

Figure 11 graphs the distribution of respondents' usage of EFS in 1989 and 1990. A higher percentage of respondents filed electronically in 1990 than in 1989, but the proportion of direct filers did not increase.

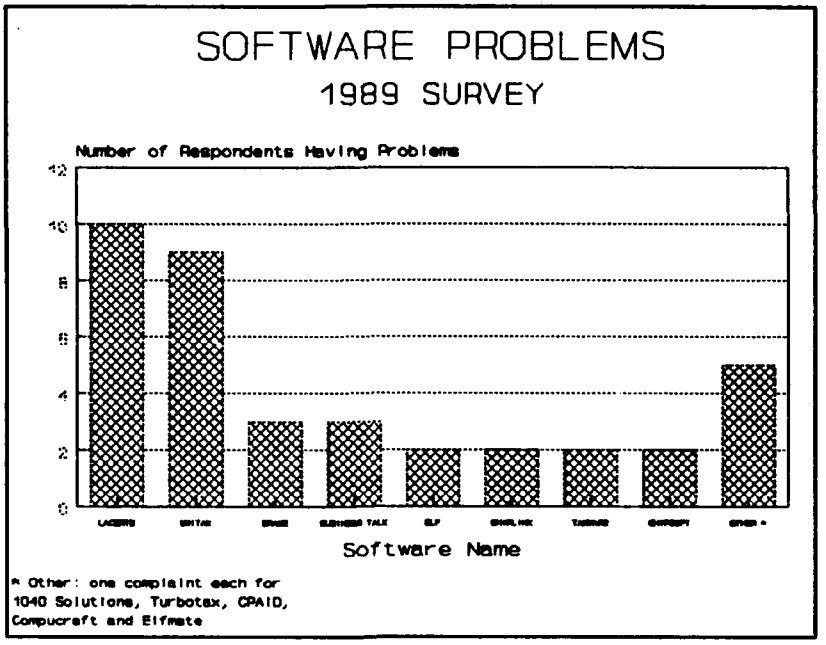


Figure 9. Software Problems--1989

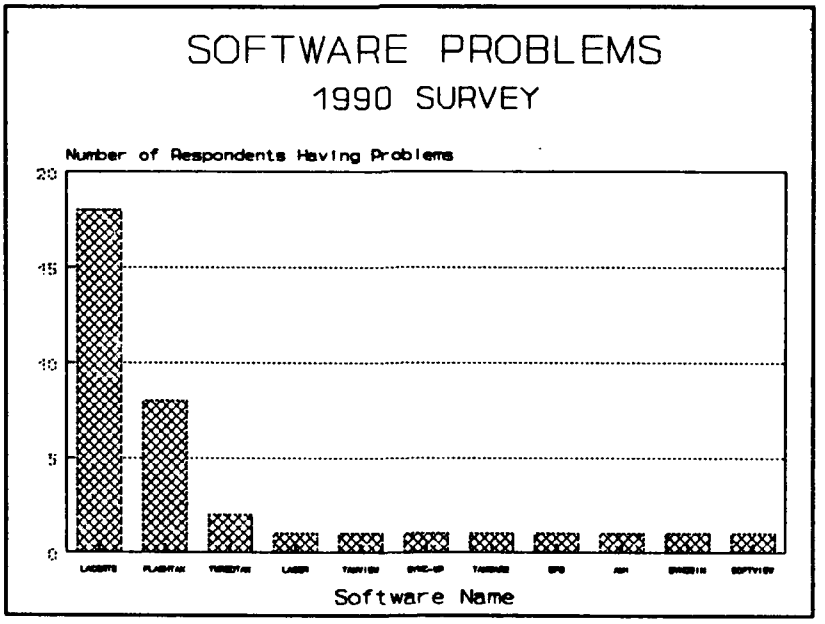


Figure 10. Software Problems--1990

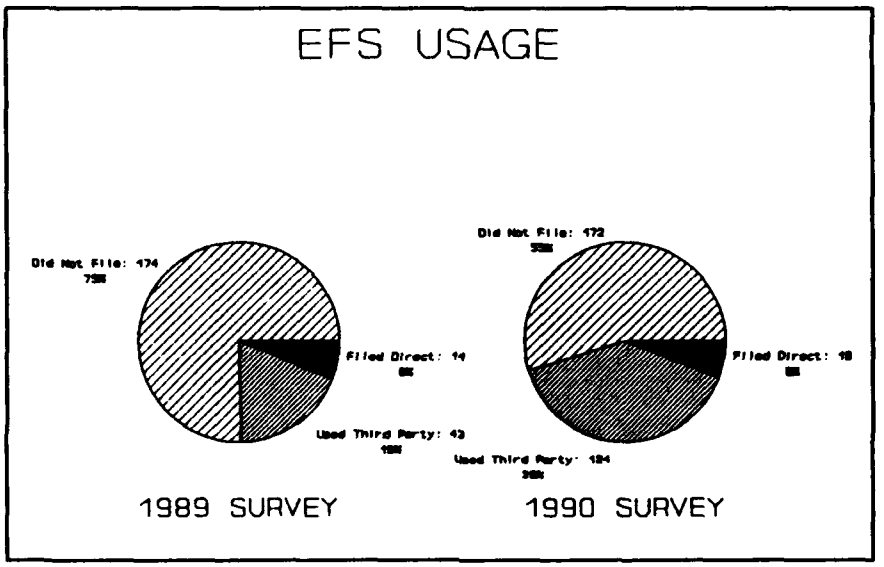


Figure 11. EFS Usage--1989 and 1990

3. Summary of Study Statistical Analysis

a. Data Interpretation Methods

Data contained in the Electronic Filing Report and in the survey responses were analyzed separately and, where possible, in combination to determine whether a significant predictor could be found for the rejection percentage. In most cases the survey respondent's name and address was on the mailing label on the survey questionnaire and could be used to ascertain the respondent's EFIN from an alphabetical list of EFIN holders. Information from the survey could thereby be compared to information on rejection percentage and number of returns filed in the Electronic Filing report. The statistical computer package Minitab was used to perform the analysis. A detailed description of the analysis is included in Appendix C; a summary follows.

b. Regression Analysis

A regression analysis was performed to determine how much of the variation in rejection percentage could be accounted for by EFIN and number of returns submitted electronically. The Electronic Filing Report was the source of the data so the analysis applied to 1990 filers only. The EFIN was selected as a possible predictor because EFINs are assigned consecutively and carry over from year to year so a lower EFIN indicates longer involvement with the program and, potentially, more interest in or more extensive knowledge of electronic filing. The magnitude of the EFIN, however, does not indicate how much experience the filer has had with the program; therefore, the number of returns filed electronically was selected as a second possible predictor. Following the regression analysis, graphs of the relationships of EFIN to rejection percentage and number of returns submitted to rejection percentage were plotted and examined to determine whether a relationship other than linear might exist.

The regression analysis resulted in a coefficient of determination of 3.6 percent which indicates that very little of the variation in the percentage of rejections can be accounted for by EFIN and number of returns filed electronically. However, subsequent examination of the graph of rejection percentage as a function of number of returns submitted (Figure 12) revealed that the plot approximates a curve which indicates that the percentage of rejections drops off sharply as the number of returns submitted approaches 500 and more slowly beyond 500, approaching zero as the number of returns increases. It appears, therefore, that the number of returns submitted may be a predictor of rejection percentage in that the more returns submitted by an EFIN, the lower the

percentage of rejections. This does not mean that filers who submit relatively few returns will necessarily have high rejection percentages. Of 252 filers who filed fewer than 50 returns, 88 (35 percent) had no rejections. In general, however, a filer who submits a large number of returns (more than 500) can be expected to have a relatively low (less than ten percent) percentage of rejections.

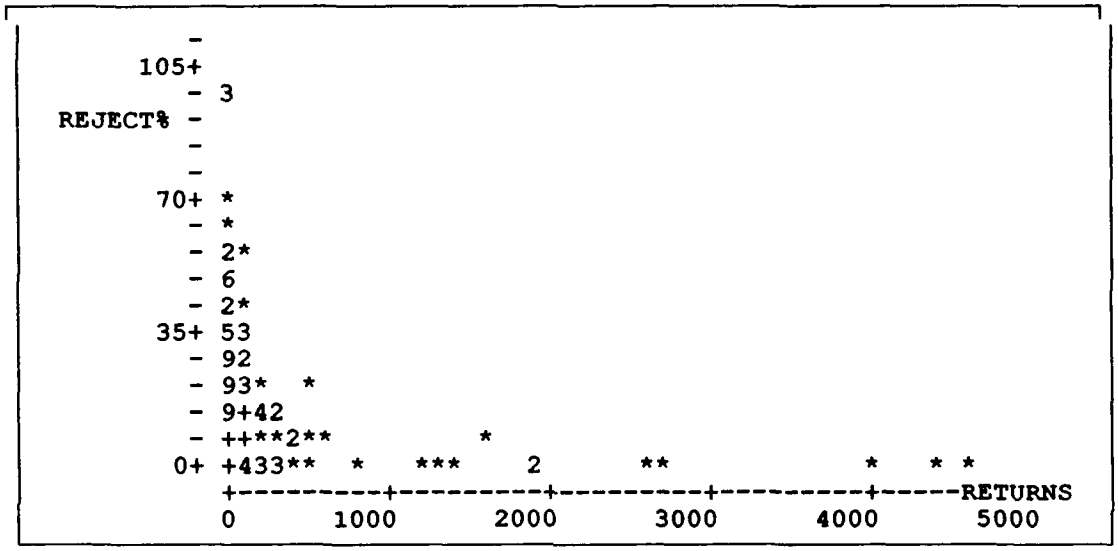
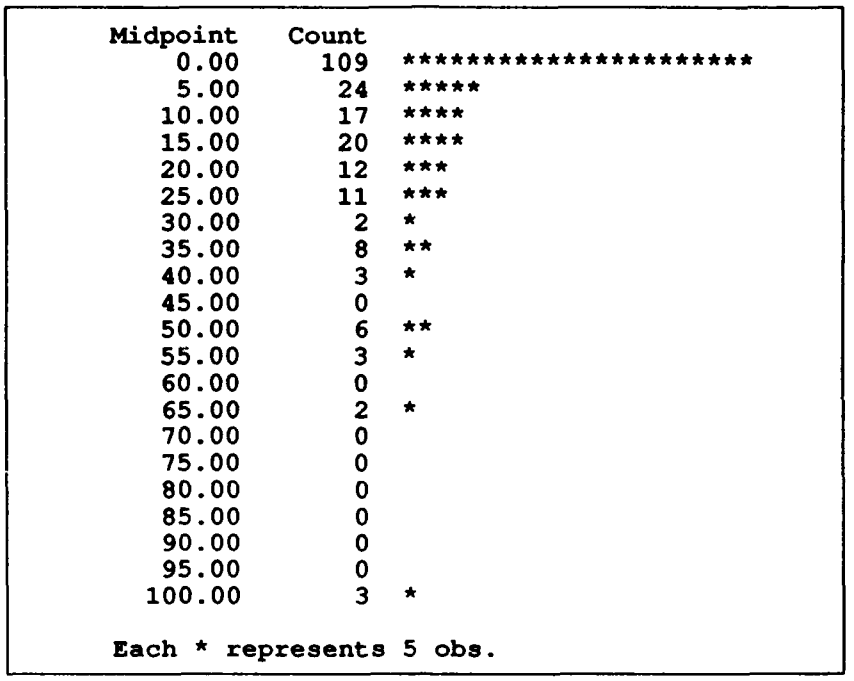


Figure 12. Plot of Rejection Percentage as a Function of Number of Returns Submitted.

c. Hypothesis Tests

The hypothesis tests which were performed during the analysis assume a normally distributed population. The population of rejection percentages from the Electronic Filing Report is not normally distributed, as shown in the histogram in Figure 13. Consequently, the results of hypothesis tests which compare sample means to the mean of the population of rejection percentages may not be conclusive but are included for information.



Midpoint	Count	
0.00	109	**********
5.00	24	*****
10.00	17	****
15.00	20	****
20.00	12	***
25.00	11	***
30.00	2	*
35.00	8	**
40.00	3	*
45.00	0	
50.00	6	**
55.00	3	*
60.00	0	
65.00	2	*
70.00	0	
75.00	0	
80.00	0	
85.00	0	
90.00	0	
95.00	0	
100.00	3	*

Each * represents 5 obs.

Figure 13. Histogram of Rejection Percentages.

(1) Transmission Method. Hypothesis tests were performed to determine whether the method of transmission used by an electronic filer (filing directly or through a third party transmitter) resulted in significantly higher or lower rejection percentage than the population of all filers. A hypothesis test was also performed to determine whether direct filers had a lower percentage of rejections than filers who used third party transmitters. Data on the method of transmission was obtained from the 1990 survey and linked to rejection percentage on the Electronic Filing report through the EFIN.

Neither direct filers nor filers using third party transmitters had significantly lower or higher, respectively, rejection percentages than the population of all 1990 filers. Direct filers did have a lower percentage of rejections at a ten percent

significance level than users of third party transmitters; however, the number of returns submitted by direct filers is greater than the number of returns submitted by users of third party transmitters at a five percent significance level. The difference in error rates may therefore be a result of the volume of returns filed and not the method of transmission.

(2) Two Year Filers. In order to determine whether filers who used electronic filing in both 1989 and 1990 had a lower percentage of rejections than the population of all 1990 filers, a hypothesis test was performed to compare the mean of the sample of two year filers to the population mean. The sample included all filers who responded to both the 1989 and 1990 surveys, who indicated on the 1989 survey that they filed in 1989, and who were listed in the Electronic Filing Report as filing in 1990. The EFIN was again used to link the survey information to the Electronic Filing Report.

Filing in two consecutive years does not appear to have a significant effect on the rejection percentage. At a five percent significance level, test data did not provide sufficient evidence to conclude that filers who filed in both 1989 and 1990 had a lower percentage of rejections than the population as a whole.

(3) Problems with Software. The rejection percentages for 1990 survey respondents who reported problems with software were analyzed using hypothesis tests to determine whether users of the most trouble-prone software had higher rejection percentages than the population of all filers. Only software reported by five or more respondents was considered; therefore, only Flashtax and Lacerte are included in the analysis.

Five or more users reported having problems using Flashtax or Lacerte software in 1990. At a five percent significance level, test results did not provide sufficient evidence to conclude that filers who had problems with Flashtax or Lacerte software had a higher rejection percentage than the population.

(4) Third Party Transmitters. Similarly, the rejection percentages for 1990 survey respondents who reported using third party transmitters were analyzed to determine whether the transmitter affected the rejection percentage. Only transmitters used by five or more respondents were considered: Compucraft, CSC-TACS, Lacerte and Flashtax.

The choice of third party transmitter may have an effect on the percentage of returns rejected. At a five percent significance level, Flashtax users had a higher rejection percentage than the population. At a ten percent significance level, however, Lacerte and CSC-TACS users also had higher rejection percentages while Compucraft users had a lower percentage of rejected returns. (It should be noted that Lacerte used Flashtax to transmit electronic returns in 1990.)

V. IMPLEMENTATION OF EFS--A CASE STUDY

A. APPLICABILITY OF CASE STUDY APPROACH

The articles by Lee [Ref. 18] and Benbasat, Goldstein, and Mead [Ref. 17] discussed in Chapter II support the use of a case study approach to MIS research. This approach is applicable to this study for a number of reasons. Benbasat, Goldstein, and Mead cite the complexity of multivariate research methods and the requirement for a normal distribution as two reasons for using case study [Ref. 17:p. 369]. The absence of distributional normality in the study data was discussed in Chapter IV. Without qualitative analysis, it is difficult to develop a meaningful interpretation of the results of the quantitative analysis. This case study is intended to expand on the information gleaned from the statistical analysis in discussing the participation rate in EFS.

B. CLASSIFICATION OF USERS

Implementation of EFS involves many different categories of users in many different organizations. Different users include taxpayers, preparers, managers of a firm which files returns electronically (filer management), IRS return processing technicians, and IRS managers. Using Cotterman and Kumar's user cube [Ref. 13:p. 1316] to classify system users shows how diversely distributed the various users are (Figure 14). (Although preparers and IRS technicians are represented by the same point, their involvement is with entirely different equipment, hence, each is located at the midpoint

of the operation dimension.) Successfully designing and implementing a system to satisfy such a diversity of users is understandably a difficult task.

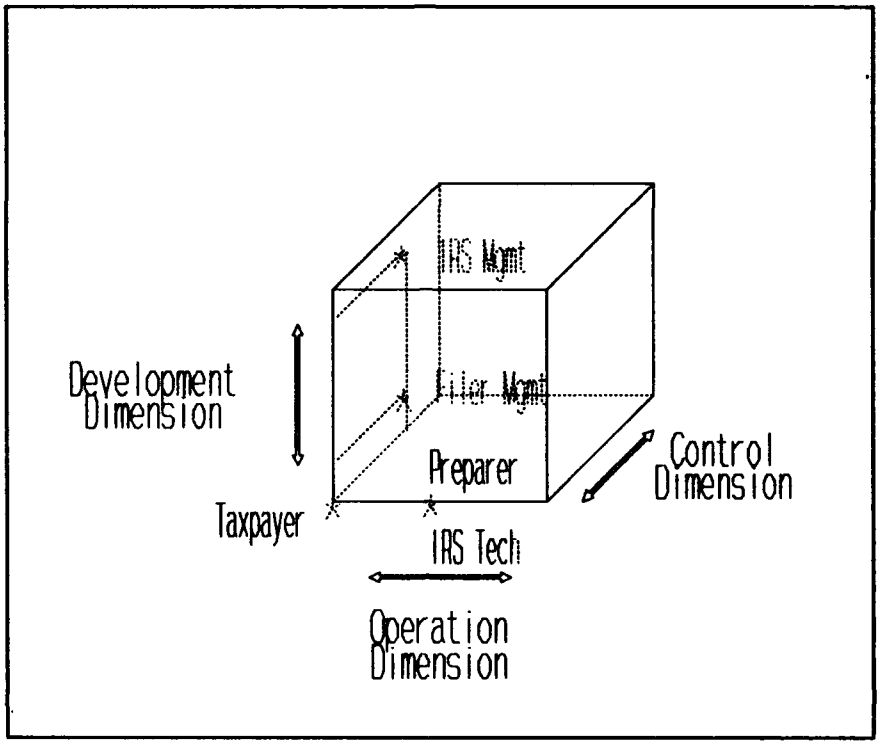


Figure 14. Taxonomy of EFS Users

C. IMPLEMENTATION PROCESS

Srinivasan and Davis state that introduction of new technologies and diversity of user types necessitate a process of implementation in which the implementors act as facilitators and coaches [Ref. 2:p. 67]. Comments of survey respondents indicate that their perception of the IRS's implementation process is more authoritative than facilitating, and that they would prefer the latter approach. Boehm and Ross have proposed an approach to management which they call Theory W; its fundamental

principle is, "Theory W: Make Everyone a Winner." [Ref. 23:p. 902] Survey respondents seemed to favor a process which acknowledged the variety of users and their different needs and responded to each in a positive way, akin to applying Theory W to management of EFS by the IRS.

D. REASONS FOR NOT USING EFS

The comments offered by survey respondents provide insight into the perceived reasons for success of EFS from the preparers' perspective. The reasons for not using EFS in 1990 can be broken down into six general areas, displayed graphically in Figure 15. The most significant reason--no client interest--includes both disinterest by clients of preparers and lack of qualified clients, either because they did not receive refunds or because their returns required forms which EFS could not handle. Cost was another frequently mentioned reason for not using EFS. Comments indicated that some preparers felt the program was not cost effective or that the cost to clients was too high.

E. SUCCESS FACTORS

Literature discussed in Chapter II suggests several factors for success in the areas of end-user computing and implementation of management information systems. Among the success factors which apply to EFS are the following: (1) planning, (2) user participation, (3) user attitude, (4) cost, (5) timeliness, (6) technical quality, (7) user friendliness and ease of use, and (8) training.

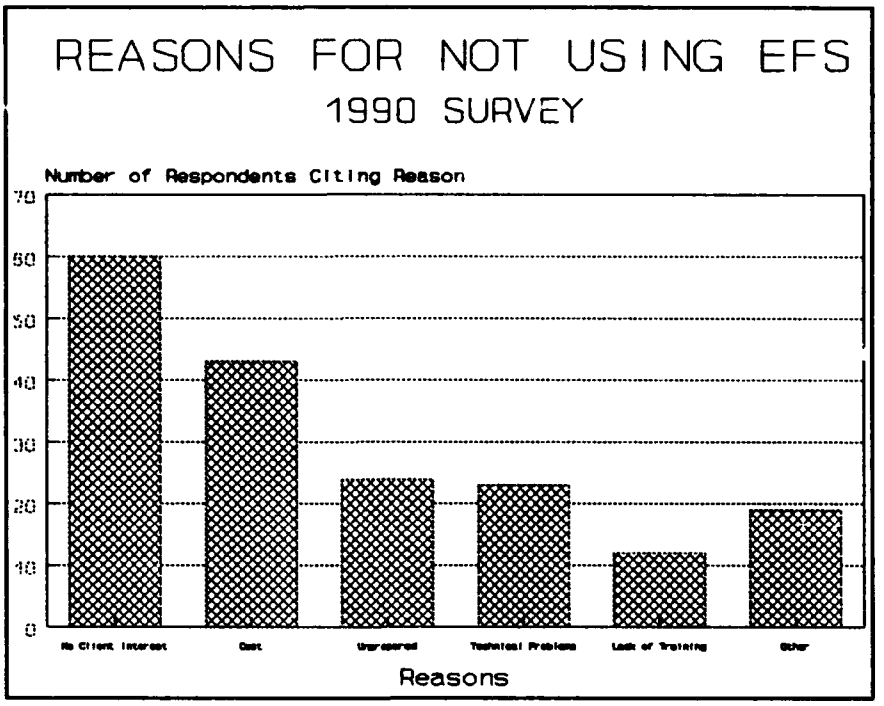


Figure 15. Reasons For Not Using EFS--1990

1. Planning

Planning was mentioned as a success factor by Rivard, who emphasized the need for careful planning in the determination of users' requirements [Ref. 4:p. 33]. Careful planning might have increased participation in EFS by making the system meet the needs of a wider range of users. As an example, survey respondents in 1989 and 1990

voiced dissatisfaction with the IRS's choice of modem baud rate for transmitters. Many of these respondents had modems already and balked at investing in a 4800 or 9600 baud modem only for EFS. Had these users been able to use the modems they owned, they

could have participated as direct filers who, as survey results indicate, file significantly more returns than those who use third party transmitters.

2. User Participation

User participation is a success factor which is related to planning in that the successful determination of user requirements during planning is facilitated by the participation of users [Refs. 6,10]. Had users been consulted before the required modems were selected, for instance, a different decision might have been made which would have resulted in more preparers' being able to file directly. Lucas states that user participation in system design ultimately results in high levels of use [Ref. 6:p. 23]. The IRS has recognized the importance of user participation, holding a Participants' Information Exchange Day, for example, on April 26, 1990, for 26 selected participants. The conference "...provided the opportunity for Electronic Filing participants to express their opinions regarding improvement of the entire Electronic Filing program, including testing and processing at the service centers." [Ref. 24:p. 2] The San Jose district survey is another indication that the IRS is aware of the importance of user participation in system implementation.

3. User Attitude

In discussing the importance of user attitude to the successful implementation of information systems, Lucas states that, "Favorable attitudes and perceptions...are associated with high levels of use of information systems." [Ref. 6:p. 105] Desanctis and Courtney also emphasized the significance of user attitude [Ref. 8]. When considering

taxpayers as users of EFS, it appears that their attitude as a group is not overwhelmingly positive. Figure 14 indicates that the reason preparers cited most often for not filing electronically was a lack of client interest. In some cases, clients were not eligible to file electronically; but, in most cases, survey respondents commented that they had no requests to file electronically or that clients were reluctant to use EFS because it was too costly or slower than advertised by the IRS. In short, many taxpayers could perceive no advantage in using EFS. Preparers as a group seemed to be more positive; many were very enthusiastic about EFS and its potential for the future even if they experienced problems using the system. Not all were in favor of EFS, however, such as the preparer who commented on the 1990 survey, "I discouraged my clients as it is a financial ripoff." According to Leonard-Barton, implementors must build positive influences and counter negative ones to facilitate acceptance of innovations [Ref. 12:p. 6]. To increase taxpayer participation, many survey respondents suggested increased marketing on the part of the IRS to acquaint taxpayers with the benefits of using EFS, in conjunction with increased effort to fulfill their marketing promises--specifically, providing refunds as quickly as advertised.

4. Cost

Cost was a frequently recurring complaint which affected users' attitudes. Cost was the second most often cited reason on the 1990 survey for not filing electronically. Reduction of costs was one of the objectives for EFS [Ref. 20:p. 2], but the perception of survey respondents was that the only stakeholder enjoying cost reductions was the IRS. Taxpayers pay for the service which is often no faster than filing

a paper return. Preparers must invest in hardware and software and suffer reduced productivity while learning to use the system. Comments such as these from the 1990 survey were common: "Program is too costly and time consuming for preparer," and "Cost of filing was too much for clients." Cost of a modem and communications software was mentioned repeatedly as a reason for filers' not filing directly.

5. Timeliness

Doll and Torkzadeh list timeliness as a component which determines user satisfaction [Ref. 15:p. 268]. A frequently mentioned drawback of EFS on both 1989 and 1990 surveys was that the system was not timely in providing refunds. Slower refunds when compared to paper returns and higher costs reduce the participation rate in EFS. One 1990 survey respondent commented, "All my clients complained because their refunds took many weeks. Stopped using it--clients said they wouldn't use it again." The IRS has recognized the importance of timeliness, as evidenced by the following comment in a briefing by the Assistant Commissioner (Returns Processing):

> In the individual return arena,...,speed is critically important in meeting the needs of the individual taxpayer and cost to accomplish this is less important. The Electronic Filing Systems Office has attempted to maintain these objectives in its development efforts--maximum service to the public at the least cost to the Government. [Ref. 20:p. 2]

The IRS appears to subscribe to the Theory W approach, but users continue to observe shortcomings.

6. Technical Quality

Technical quality of the system is another success factor which is mentioned often in the literature. Lucas states that, "...systems with high technical quality are associated with high levels of use of information systems." [Ref. 6:p. 105] Technical problems accounted for 13 percent of survey respondents' reasons for not filing electronically in 1990 and for 44 percent of respondents having problems with the system in 1990. Some problems were minor while others were more serious, such as the 1990 respondent who said he was "Unable to transmit because of software." Some respondents suggested that the IRS offer software as a means of ensuring better quality control. The IRS has offered the following response:

> The two primary reasons the EFS Office has not done this are to avoid competition between the government and private industry in software development, and the government cannot be held accountable for erroneous submissions. By not becoming involved in actual return preparation software, the IRS can maintain its proper autonomy in meeting its mission of Tax Administration. [Ref. 20:p. 3]

7. User Friendliness and Ease of Use

User friendliness and ease of use are two technological factors which contribute to user satisfaction [Ref. 4:p. 26]. Doll and Torkzadeh suggest ease of use as one component which determines user satisfaction [Ref. 15:p. 268]. Rivard and Huff include user friendliness in their list of success factors for end-user computing [Ref. 16:p. 558]. Rushinek and Rushinek also cite user friendliness as an important factor in user satisfaction [Ref. 25:p. 594]. Survey comments indicated that many preparers felt the system was not particularly easy to use or user friendly. One 1990 respondent summed

it up this way, "Make program simpler for users." The third most often mentioned problem area on the 1990 survey was error codes (see Figure 4). Typical comments were, "Need better error code explanations," and "Want error codes more specific." Poor quality manuals were another frequent complaint. The procedure for filing electronically requires that the taxpayer's W-2 forms and a signature form (Form 8453) be sent to the IRS in the traditional manner, by mail. Preparers' commented that this procedure was cumbersome.

8. Training

Survey respondents indicated that they wanted more and earlier training in EFS. Lack of training was the fifth most frequently mentioned reason 1990 survey respondents gave for not filing electronically. Some of the problems preparers experienced with manuals and error codes might have been eliminated or reduced if preparers had been thoroughly trained. Their frustration with using the system would almost certainly have been lessened with training, and their satisfaction consequently increased.

F. FAVORABLE COMMENTS

Not all the comments were critical of EFS, however. There were almost half as many positive comments as there were negative ones on the 1990 survey, most of them indicating satisfaction with the system while some were very enthusiastic. Positive comments ranged from "Best the IRS has made in years," to "Interesting program." Survey respondents were especially pleased with the service provided by the coordinators

at the Ogden Service Center. A good indicator of users' satisfaction with the system is participation. In 1988, 1.53 percent of paid preparer refund returns in the San Jose district were filed electronically; in 1989, an estimated 2.53 percent were filed electronically; and, in 1990, the figure rose to 5.00 percent [Ref. 19]. The participation rate is showing a favorable trend, indicating that users' overall perception of EFS is positive.

VI. DISCUSSION AND RECOMMENDATIONS

A. DISCUSSION OF THE ERROR RATE

The results of the statistical analysis of the survey data do not reveal conclusive evidence to explain why some filers have higher error rates than others. It appears that filers who file more than 500 returns electronically in a season are likely to have a rejection percentage below ten percent; however, many lower volume filers also have similarly low rejection percentages. The choice of third party transmitter may have an effect on the error rate--Flashtax, Lacerte and CSC-TACS users all had higher rejection percentages than the population while Compucraft users had a significantly lower percentage of rejections. Further research would be necessary to determine whether there is a causal relationship between selection of transmitter and error rate.

The effect of method of transmission (direct or through a third party) is inconclusive as it may be a result of the larger volume of returns filed by direct filers compared to those who use third party transmitters. Neither length of involvement with EFS nor filing in two consecutive years appears to have a significant effect on the error rate. Filers reporting problems with their software did not have a higher rejection percentage than those who did not report problems, so no specific software packages can be pinpointed as less effective in handling errors.

The San Jose District EFS Coordinator conducted a telephone survey in 1990 of filers with error rates over 10 percent. The survey revealed that most respondents

attributed their high error rate to either software problems or human error. These problems could be symptomatic of poor software design, insufficient testing of software, poorly written manuals, or inadequate training.

B. RECOMMENDATIONS FOR REDUCING THE ERROR RATE

The following recommendations are proposed to reduce the error rate among filers: (1) more intensive training of individuals who will be preparing electronic returns and (2) more stringent requirements and testing for software developers prior to being listed as "accepted" by the IRS.

A frequently recurring comment among survey respondents was that there was a need for more training for electronic filers. More intensive training could alleviate the human error problem to some extent although it can never be entirely eliminated. Since experience using EFS (filing more returns during the filing season) seems to relate to a lower rejection percentage, training of low volume filers might compensate for their lack of experience.

More exhaustive testing by the IRS prior to listing software as "accepted" would ensure that filers would use only well designed, less trouble prone software. Among 1990 survey respondents, 24 reported dissatisfaction with error codes provided by the software they used. Their comments indicated that the codes were difficult to interpret, and the process for correcting errors was not easy to discern. Poorly written manuals were another frequent complaint. If the IRS applied more rigorous standards in the software acceptance process, with emphasis on ease of use and error detection/correction, then

errors could be either avoided or detected and eliminated by the software before returns were transmitted.

C. DISCUSSION OF THE PARTICIPATION RATE

The case study of EFS, with particular emphasis on the participation rate, revealed that users were, in general, pleased with the concept of EFS and its potential for speeding the processing of tax returns. The participation rate in the San Jose district has increased each year since the system was introduced.

The different categories of users of EFS make its successful implementation a complex process. Taxpayers want prompt refunds for the least cost; tax preparers want fast, efficient processing of returns which generates a profit; the IRS wants cost economies. The emphasis in design and implementation of EFS appears, from the taxpayers' and preparers' points of view, to be on a system which meets the IRS's needs, and falls short of meeting taxpayers' and preparers' needs. Participation in EFS is, therefore, not as high as it could be.

The study considered factors which influence the participation rate and determined the factors which had the most significant impact. These factors were planning, user participation, user attitude, cost, timeliness, technical quality, user friendliness and ease of use, and training.

D. RECOMMENDATIONS FOR INCREASING THE PARTICIPATION RATE

The success factors form the basis for recommendations for increasing the participation rate in the San Jose district. The recommendations can be generalized to

apply to all IRS districts. The following recommendations are proposed:

1. Solicit, consider, and act upon suggestions and comments from taxpayers and tax preparers.

2. Ensure that EFS delivers refunds faster than traditional filing methods and within the time period advertised.

3. Rigorously test software before listing it as "accepted".

4. Develop an effective training program for preparers and offer it early enough to permit preparers to have completed it before the start of the filing season.

As the responses to the two surveys demonstrate, tax preparers appear eager to offer suggestions for improving EFS. If the IRS were to permit active participation of users in determining improvements to the system, then overall participation in EFS would be likely to increase. Specific recommendations which survey respondents made which appear to merit consideration are:

1. Permit users to transmit with modems of less than 4800 baud rate.

2. Allow taxpayers to deduct from their taxes, or at least partially refund, the electronic filing fee.

Timeliness of refunds is important to the taxpayers and is the major advantage EFS offers them over filing paper returns. If the system is no faster, or if it fails to live up to its promises, then taxpayers will not use it and participation will not increase.

More rigorous testing of software would eliminate many of the problems preparers experienced in using, or attempting to use, EFS. More preparers would probably be interested in using the system and in encouraging taxpayers to use it, if it were easier to use. Better quality software would also reduce the cost to preparers by allowing them to

devote more of their time to preparation of tax returns rather than to attempting to resolve problems with the software or to correcting and resubmitting rejected returns.

Training was mentioned often by survey respondents as an area which could be improved. The comments on training indicated that preparers would like to see more training offered and that the timing of the training was important. Training would be most beneficial before the start of the filing season so that preparers are familiar with the system and can handle clients' requests for electronic filing efficiently once the filing season begins.

E. LESSONS LEARNED FOR SUCCESSFUL IMPLEMENTATION

Many lessons can be learned from the implementation of EFS. One of the most important is that, when implementing a large scale computer system, consideration must be given to the needs of all users or stakeholders. The best way to determine these needs is to allow each group of users to participate in the design and implementation of the system. It is not possible to satisfy all needs of all groups of users--at times they conflict and a compromise or decision in favor of one group must be made. An effort should be made to consider each group and balance their respective needs and desires. Each group of users must perceive some advantage to using the system or they will not participate.

Quality control of software can have significant results. If it is effective, it can encourage increased participation and decrease errors in using the system. If it is ineffective, users will be discouraged from using the system because of the problems they encounter with the software.

From a marketing point of view, it is important to promise no more than can be delivered; otherwise, users may become frustrated and stop using the system. Potential new users will be less inclined to use the system if it has a reputation for failing to produce as expected.

The implementor of a large scale computer must at all times be cognizant of the needs of all the system's users and must strive to meet as many of these needs as possible. The IRS is making progress--participation in EFS continues to increase and the error rate remains significantly below that for paper returns.

APPENDIX A

GLOSSARY OF TERMS AND ACRONYMS

Term/Acronym	Meaning
direct filer	Filer who files returns electronically using his own modem/equipment.
DIS	Distributed Input System
EF	Electronic Filing
EFIN	Electronic Filing Identification Number
EFS	Electronic Filing System
electronic return collector	Individual or firm which accepts prepared returns directly from taxpayers from which it produces electronic returns.
filer	Individual or firm that files returns electronically.
filing season	Period during which tax returns are filed. Normally January to April 15 of the year following the applicable tax year.
IRS	Internal Revenue Service
IS	Information System
MIS	Management Information System

preparer	Individual or firm which fills in an electronic return and computes the tax based on information the taxpayer provides.
preparer/transmitter	Individual or firm which performs the same role as a preparer and also transmits returns directly to IRS.
service bureau	Tax return processor who provides a variety of services to tax preparers, including collection or transmittal of returns to the IRS.
tax practitioner	Individual or firm which prepares or transmits electronic returns to the IRS.
tax year	Calendar year for which tax is paid/withheld.
third party transmitter	Service bureau or other organization which transmits prepared returns electronically for tax preparers who are not equipped to file directly.
transmitter	Individual or firm which transmits returns directly to the IRS.

APPENDIX B

SURVEY QUESTIONNAIRES AND IRS SUMMARY REPORTS

I. SURVEY QUESTIONNAIRES

A. 1989 SURVEY

PLEASE HELP US TO HELP YOU!

You are part of a group of tax practitioners who applied to participate in electronic filing. Although we may have talked by phone, please take a moment to provide the electronic filing program with valuable feedback. Please let us know problems experienced and how we can better serve you. We especially want to hear from those who applied but did not file returns this past filing season under your own EFIN. You can fold this note, staple it, and mail back to us, postage paid.

MARK EACH BOX THAT APPLIES:

☐ I applied but did not file electronically.
☐ My clients filed their returns electronically through _____
☐ I applied to keep informed of new technology.
☐ Other _____

I had trouble with my

☐ hardware
☐ modem
☐ software (which was _____
☐ transmitter (who was _____
☐ other _____

My software vendor _____ (name)

- ☐ did not pass PATS testing
- ☐ did not complete PATS timely
- ☐ other _____

My transmitter _____ (name)

- ☐ did not pass PATS testing
- ☐ did not complete PATS timely
- ☐ other _____

I couldn't justify the expense

- ☐ of the software
- ☐ of the hardware
- ☐ of the additional labor/overhead
- ☐ other _____

☐ I would like to participate next year. I would like to see the following changes:

_____

_____

☐ How can we better serve you? _____

_____

☐ Other problems experienced. _____

_____

B. 1990 SURVEY

Help Us Help You!

Please take a few minutes to fill out this Electronic Filing Questionnaire. We are seeking your feedback on the 1990 Electronic Filing Season. We want your candid comments, pro and con. This is your opportunity to let us know your ideas on how we might improve the system. Once the questionnaire is completed, please fold, staple and mail back to us...postage paid. We appreciate your comments...

PLEASE MARK EACH BOX THAT APPLIES

☐ I transmitted directly to the IRS

used 4800 _____ or 9600 _____ Baud Modem

Name of Modem _____

I recommend Yes _____ No _____

Comments _____

☐ I transmitted through Third Party,

Name of Transmitter _____

I recommend Yes _____ No _____

☐ I was accepted for EF but did not file Electronically because _____

_____

I had trouble/problem with:

☐ Software. Name _____

☐ Getting Software Manual _____

☐ Third Party Transmitter. Name _____

☐ Getting Acknowledgement File _____

I had trouble/problem with:

- ☐ Understanding Error Codes _____
- ☐ Purchasing Equipment _____
- ☐ Cost of Equipment _____
- ☐ Routing Transit numbers and account numbers of Credit Unions/Banks. Names _____

_____

- ☐ Direct Deposit _____
- ☐ Proof of Direct Deposit _____
- ☐ Ogden Service Center _____
- ☐ Other _____

_____

Feedback: Positive and Negative

_____

_____

Changes you want to see in the program _____

_____

How can the Electronic Filing Coordinator better serve you _____

_____

_____

II. IRS SURVEY SUMMARY REPORTS

A. 1989 SUMMARY REPORT

BREAKDOWN OF RESPONSES	TOTAL
DID ELECTRONICALLY FILE	61
DID NOT ELECTRONICALLY FILE	165
APPLIED TO KEEP INFORMED	33
OTHER	8
TROUBLE	
HARDWARE	6
SOFTWARE	34
MODEM	9
TRANSMITTER	68
REFUND TOO SLOW	19
PROGRAM TOO COMPLICATED	6
NEED BETTER ADVERTISING	12
NOT ENOUGH CLIENT INTEREST	28
OTHER	3
PREPARER ACCEPTANCE TESTING SYSTEM	
SOFTWARE VENDOR	58
SOFTWARE - NOT PASS	2
SOFTWARE - NOT COMPLETE	2
TRANSMITTER VENDOR	51
TRANSMITTER - NOT PASS	0
TRANSMITTER - NOT COMPLETE	3
OTHER	8
TOO EXPENSIVE !!!!	
SOFTWARE	42
HARDWARE	25
LABOR/OVERHEAD	35
OTHER	19
WILL YOU PARTICIPATE NEXT YEAR?	**YES - 190**
	NO - 3

TOTAL NUMBER OF RESPONSES TO THE 450 QUESTIONNAIRES SENT IS: 234

B. 1990 SUMMARY REPORT

	TOTAL
BREAKDOWN OF RESPONSES	
DIRECT TRANSMITTER.....:	28
4800 MODEM.....:	28
9600 MODEM.....:	0
RECOMMENDED.....:	26
TRANSMITTED THROUGH THIRD PARTY....:	179
RECOMMENDED.....:	7
ACCEPTED/NOT FILED.....:	178
TROUBLE	
SOFTWARE.....:	53
GETTING MANUAL.....:	7
3RD PARTY.....:	20
ACKNOWLEDGEMENT.....:	11
ERROR CODES.....:	18
PURCHASING EQUIPMENT.....:	17
COST OF EQUIPMENT.....:	7
RTN.....:	16
DIRECT DEPOSIT.....:	7
PROOF OF DIRECT DEPOSIT.....:	8
OGDEN.....:	4
OTHER.....:	71

TOTAL NUMBER OF RESPONSES TO THE 650 QUESTIONNAIRES SENT IS: 373

APPENDIX C

STATISTICAL ANALYSIS

I. DESCRIPTION

A. Computer Package and Tests

A statistical analysis of the data provided by the IRS was performed using the statistical computer package Minitab. Two different hypothesis tests were used as required. The Minitab ZTEST was used to compare a sample mean to the population mean when the sample was large ($n >= 30$) or the standard deviation of the population was known. The Minitab TWOSAMPLE T test was used to compare the means of two small ($n < 30$), independent samples whose population standard deviations were unknown but not assumed equal. A detailed description of the results of the tests follows. Unless otherwise specified, "population" refers to the population of rejection percentages for all 1990 electronic filers which was provided by the San Jose District of the IRS.

B. Column Descriptions

The data were entered into Minitab in columns as follows:

Column No.	Column Name	Column Description
C1	EFIN	Electronic Filing Identification Number (last three digits).

C2	RETURNS	Number of returns filed electronically during the 1990 filing season.
C3	REFUND	Total amount of refunds for EF returns in 1990.
C4	REJECT%	Percentage of electronically filed returns rejected in 1990.
C5	RESIDUAL	The residuals from the regression analysis.
C6	FLASHTXS	Rejection percentages for 1990 survey respondents reporting problems with Flashtax software.
C7	LACERTES	Rejection percentages for 1990 survey respondents reporting problems with Lacerte software.
C8	COMPUCFT	Rejection percentages for 1990 survey respondents using Compucraft transmitter.
C9	CSC-TACS	Rejection percentages for 1990 survey respondents using CSC-TACS transmitter.
C10	LACERTET	Rejection percentages for 1990 survey respondents using Lacerte transmitter.
C11	FLASHTXT	Rejection percentages for 1990 survey respondents using Flashtax transmitter.
C12	3RDPRTY%	Rejection percentages for 1990 survey respondents who used third party transmitters.

C13	DIRECT%	Rejection percentages for 1990 survey respondents who filed directly.
C14	FILE2	Rejection percentages for filers who responded to both 1989 and 1990 surveys and filed electronically in both years.
C15	DRETURNS	Number of returns filed directly by 1990 survey respondents.
C16	3RETURNS	Number of returns filed through third party transmitters by 1990 survey respondents.

II. REGRESSION ANALYSIS

Printout 1 displays the results of the calculation of the linear correlation coefficient for each pair of the variables being considered. The variables RETURNS and REFUND have a correlation coefficient of 0.936, indicating that they are highly correlated with each other. In order to avoid any corruption of the results of the regression analysis by multicollinearity of variables, either RETURNS or REFUND had to be dropped from consideration. Since refunds are more realistically dependent on number of returns submitted than the reverse, the decision was made to use the RETURNS data. Consequently, REFUND was not considered as a variable when performing the regression analysis.

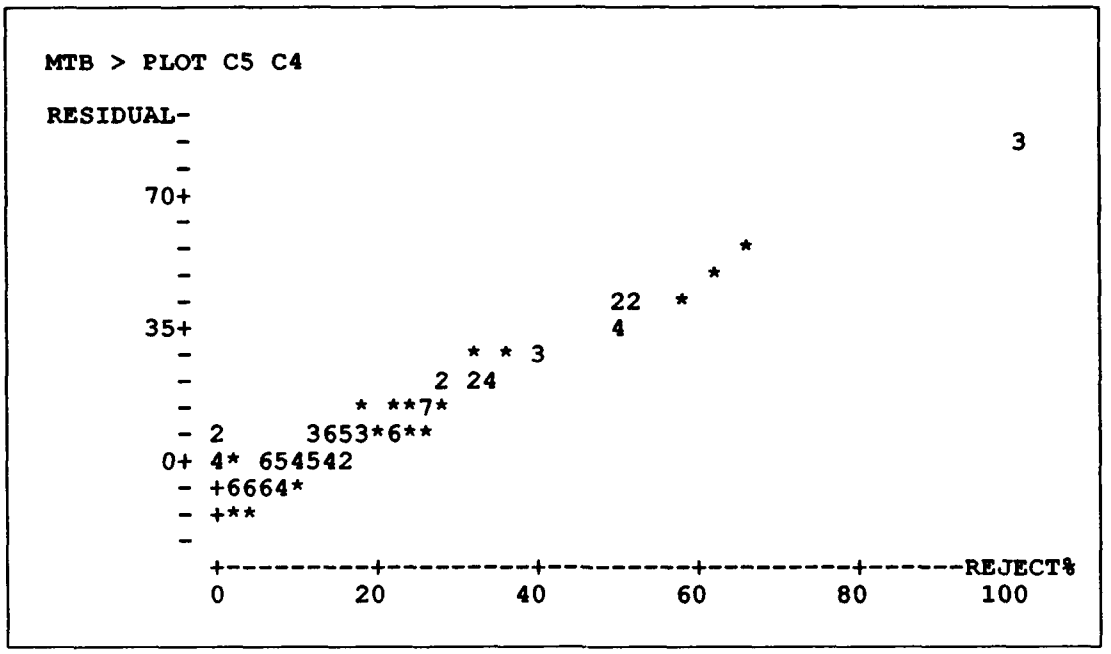
```
MTB > CORR C1-C4

            EFIN   RETURNS    REFUND
RETURNS    0.014
REFUND     0.009     0.936
REJECT%    0.138    -0.128    -0.137
```

Printout 1. Linear Correlation Coefficients.

Printout 2 is the regression analysis of the data with REJECT% as the dependent variable and EFIN and RETURNS as the independent variables. The results show that very little of the variation in the percentage of rejections can be accounted for by the two independent variables. Printout 3 is a graph of the residuals, indicating a strong positive linear correlation. Printout 4 shows the correlation between residuals and REJECT%.

```
MTB > REGRESS C4 2 C1 C2;
SUBC> RESIDUALS C5.
The regression equation is
REJECT% = 7.98 + 0.0113 EFIN - 0.00381 RETURNS

Predictor       Coef        Stdev    t-ratio       p
Constant       7.979        2.204       3.62   0.000
EFIN        0.011259     0.005382       2.09   0.038
RETURNS    -0.003806     0.001947      -1.96   0.052

s = 17.51       R-sq = 3.6%      R-sq(adj) = 2.7%

Analysis of Variance
SOURCE        DF           SS          MS         F       p
Regression     2       2478.6      1239.3      4.04   0.019
Error        217      66540.3       306.6
Total        219      69018.9
SOURCE        DF       SEQ SS
EFIN           1       1306.5
RETURNS        1       1172.1

Unusual Observations
Obs.     EFIN    REJECT%        Fit  Stdev.Fit   Residual   St.Resid
31         60      50.00       8.65       1.94      41.35      2.38R
35         71      50.00       8.77       1.90      41.23      2.37R
82        227      66.60      10.52       1.37      56.08      3.21R
101       315       0.80       4.21       3.60      -3.41     -0.20 X
124       401      50.00      12.49       1.27      37.51      2.15R
127       423     100.00      12.74       1.31      87.26      5.00R
130       434       0.00      -4.56       8.65       4.56      0.30 X
131       435       0.00       2.49       5.12      -2.49     -0.15 X
132       436       0.10      -2.24       7.49       2.34      0.15 X
134       438       0.10       3.12       4.82      -3.02     -0.18 X
137       441       0.10      -3.70       8.26       3.80      0.25 X
149       474      52.90      13.25       1.42      39.65      2.27R
172       549      52.80      13.82       1.64      38.98      2.24R
174       555     100.00      14.22       1.69      85.78      4.92R
178       571      62.50      14.38       1.75      48.12      2.76R
184       591      50.00      14.62       1.83      35.38      2.03R
197       630     100.00      15.06       1.99      84.94      4.88R
219       723      57.10      16.09       2.40      41.01      2.36R
R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.
```

Printout 2. Regression Analysis.



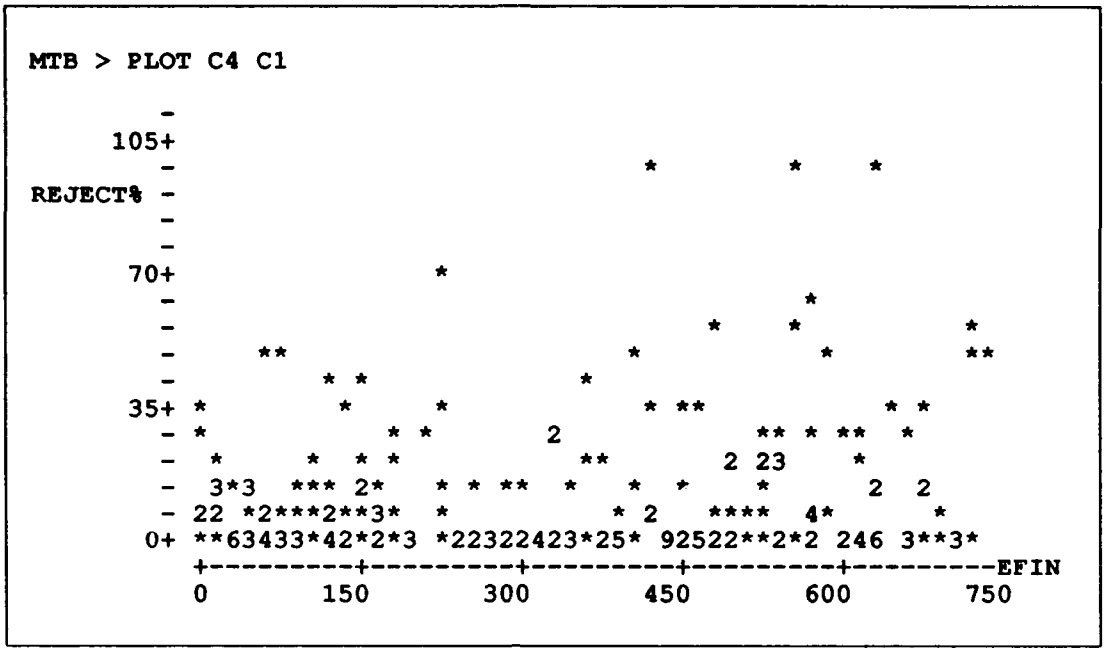
Printout 3. Plot of Residuals of Regression Analysis.

```
MTB > CORR C5 C4

Correlation of RESIDUAL and REJECT% = 0.982
```

Printout 4. Correlation Between Residuals and Rejection Percentage.

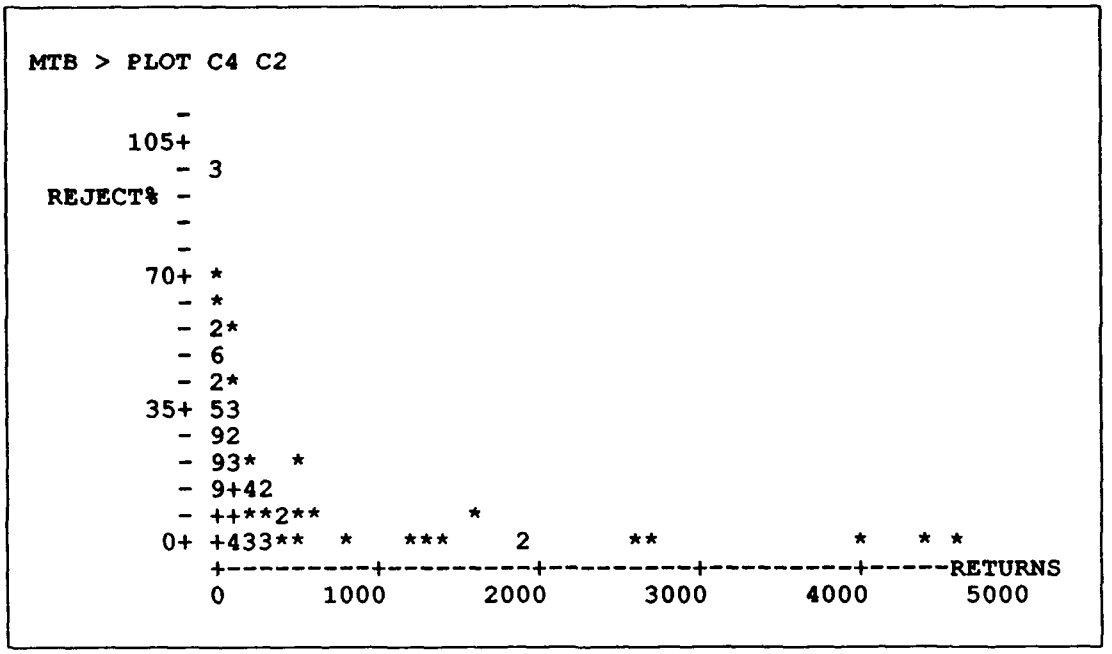
III. GRAPHS OF RELATIONSHIPS OF EFIN TO REJECTION PERCENTAGE AND NUMBER OF RETURNS SUBMITTED TO REJECT PERCENTAGE

Printout 5 graphs the relationship between EFIN and rejection percentage. As could be expected from the regression analysis (see Printout 2) and the correlation coefficient for the two variables (0.138), there appears to be little correlation between EFIN and rejection percentage.



Printout 5. Plot of Rejection Percentage as a Function of EFIN.

Printout 6 plots the relationship between number of returns submitted and the rejection percentage. The correlation coefficient of these two variables is -0.128, which indicates there is little linear correlation between the two. However, the plot appears to approximate a curve which strongly indicates that the percentage of rejections drops off sharply as the number of returns submitted approaches 500. Beyond 500 (approximately) REJECT% continues to drop, but more slowly, approaching zero as RETURNS increases.



Printout 6. Plot of Rejection Percentage as a Function of Number of Returns Submitted.

IV. POPULATION DISTRIBUTION

Printout 7 is a histogram showing the distribution of the population of rejection percentages, including the population mean and standard deviation. Some of the statistical tests which follow assume that the population is approximately normally distributed. As it does not appear to be a normal distribution, the results of some of the tests may not be conclusive.

```
MTB > HISTOGRAM C4;
SUBC> INCR=5.

Histogram of REJECT%   N = 220
Each * represents 5 obs.

Midpoint    Count
    0.00      109  **********************
    5.00       24  *****
   10.00       17  ****
   15.00       20  ****
   20.00       12  ***
   25.00       11  ***
   30.00        2  *
   35.00        8  **
   40.00        3  *
   45.00        0
   50.00        6  **
   55.00        3  *
   60.00        0
   65.00        2  *
   70.00        0
   75.00        0
   80.00        0
   85.00        0
   90.00        0
   95.00        0
  100.00        3  *

MTB > STDEV C4
   ST.DEV. =      17.753

MTB > MEAN C4
   MEAN    =      11.123
```

Printout 7. Histogram of Rejection Percentages.

V. COMPARISON OF DIRECT FILERS AND FILERS USING THIRD PARTY TRANSMITTERS

Printout 8 is a right-tailed hypothesis test which compares the mean of the rejection percentages for all 1990 survey respondents who used third party transmitters to transmit their returns (3RDPRTY%, column C12) to the population mean to determine if the sample mean is greater than the population mean at a 5% significance level. (The

Minitab ZTEST was used because it is appropriate for a sample with known standard deviation. The test assumes a normally distributed population. The population used in this analysis does not appear to be normal (see Printout 7) so the results may not be conclusive.) The results indicate that the data do not provide sufficient evidence to conclude that filers who filed through a third party had a higher percentage of rejections than the population as a whole.

```
MTB > ZTEST 11.123 17.753 C12;
SUBC> ALTE=1.

TEST OF MU = 11.123 VS MU G.T. 11.123
THE ASSUMED SIGMA = 17.8

              N      MEAN     STDEV   SE MEAN         Z     P VALUE
3RDPRTY%     84    13.249    18.339     1.937      1.10        0.14
```

Printout 8. Hypothesis Test of Mean Rejection Percentages for Filers Using Third Party Transmitters and Population.

Printout 9 is a left-tailed hypothesis test which compares the mean of rejection percentages for all 1990 survey respondents who filed directly without using a third party (DIRECT%, column C13) to the population mean to determine if the sample mean is less than the population mean at a 5% significance level. (The Minitab ZTEST was used because it is appropriate for a sample with known standard deviation. The test assumes a normally distributed population. The population used in this analysis does not appear to be normal (see Printout 7) so the results may not be conclusive.) The results indicate that the data do not provide sufficient evidence to conclude that the filers who filed directly had a lower percentage of rejections than the population as a whole.

```
MTB > ZTEST 11.123 17.753 C13;
SUBC> ALTE=-1.

TEST OF MU = 11.123 VS MU L.T. 11.123
THE ASSUMED SIGMA = 17.8

              N      MEAN     STDEV   SE MEAN         Z    P VALUE
DIRECT%      16     9.456     7.173     4.438     -0.38       0.35
```

Printout 9. Hypothesis Test of Mean Rejection Percentages for Direct Filers and Population.

Printout 10 is a right-tailed hypothesis test to determine whether filers using third party transmitters have a higher percentage of rejections than direct filers. (While the data in column C12 (3RDPRTY%) represent a large sample (n > 30), there are only 16 elements in C13 (DIRECT%), so it must be considered a small sample. Therefore, the Minitab TWOSAMPLE T test was chosen to perform the test because it applies to hypothesis tests for two means for normal populations; small,independent samples; and population standard deviations unknown and assumed unequal. The populations for this test, all direct filers and all filers who used third party transmitters, are assumed to be normal.) The results indicate that at the 5% significance level the data do not provide sufficient evidence to conclude that direct filers have a lower percentage of rejections than filers who use third party transmitters. However, at the 10% significance level, there is evidence to conclude that direct filers do have a lower percentage of rejections than filers who use third party transmitters.

```
MTB > TWOSAMPLE T C12 C13;
SUBC> ALTE=1.

TWOSAMPLE T FOR 3RDPRTY% VS DIRECT%
            N      MEAN     STDEV   SE MEAN
3RDPRTY%   84      13.2      18.3       2.0
DIRECT%    16      9.46      7.17       1.8

95 PCT CI FOR MU 3RDPRTY% - MU DIRECT%: (-1.6, 9.2)

TTEST MU 3RDPRTY% = MU DIRECT% (VS GT): T= 1.41  P=0.082  DF=59
```

Printout 10. Hypothesis Test to Compare Mean Rejection Percentages of Filers Using Third Party Transmitters and Direct Filers.

Further tests were performed to determine whether the number of returns filed by each type of filer (direct or through third party transmitter), rather than the method of filing, might have influenced the rejection percentage. Printout 11 is a hypothesis test of the means of the two samples to determine whether direct filers file more returns than those who use third party transmitters. (The Minitab TWOSAMPLE T test was used because it is appropriate for small ($n_{DRETURNS} < 30$), independent samples whose population standard deviations are unknown but not assumed equal. The populations for this test, all direct filers and all filers who used third party transmitters, are assumed to be normally distributed.) The results indicate that, at the 5% significance level, direct filers file more returns than third party transmitters. The difference in rejection percentages between direct filers and those using third party transmitters may, therefore, be due to the volume of returns filed rather than the method of transmission.

```
MTB > TWOSAMPLE T C15 C16;
SUBC> ALTE=1.

TWOSAMPLE T FOR DRETURNS VS 3RETURNS
             N      MEAN      STDEV    SE MEAN
DRETURNS    16       273        352         88
3RETURNS    84        56        213         23

95 PCT CI FOR MU DRETURNS - MU 3RETURNS: (25, 408)

TTEST MU DRETURNS = MU 3RETURNS (VS GT): T=2.38  P=0.015  DF=17
```

Printout 11. Hypothesis Test to Compare Mean Number of Returns of Direct Filers and Third Party Users.

VI. COMPARISON OF NEW FILERS WITH SECOND YEAR FILERS

Printout 12 is a hypothesis test which compares the mean of rejection percentages for each filer who responded to both 1989 and 1990 surveys and who filed returns electronically in both 1989 and 1990 filing seasons to the population mean to determine if the sample mean is less than the population mean at a 5% significance level. (The Minitab ZTEST was used because it is appropriate for a sample with known standard deviation. The test assumes a normally distributed population. The population used in this analysis does not appear to be normal (see Printout 7) so the results may not be conclusive.) The results indicate that the data do not provide sufficient evidence to conclude that the filers who filed in both 1989 and 1990 had a lower percentage of rejections than the population as a whole.

```
MTB > ZTEST 11.123 17.753 C14;
SUBC> ALTE=-1.

TEST OF MU = 11.123 VS MU L.T. 11.123
THE ASSUMED SIGMA = 17.8

              N      MEAN     STDEV   SE MEAN         Z     P VALUE
FILE2        22     8.191     9.674     3.785     -0.77        0.22
```

Printout 12. Hypothesis Test of Sample Mean and Population Mean.

VII. COMPARISON OF REJECTION PERCENTAGES FOR SOFTWARE

The rejection percentages for 1990 survey respondents who reported problems with software were analyzed to determine whether they had higher rejection percentages than the population. Only software reported by five or more respondents was considered.

Printout 13 is a hypothesis test of the mean of the rejection percentages for 1990 survey respondents who reported problems using the Flashtax software . (The Minitab ZTEST was used because it is appropriate for a sample with known standard deviation. The test assumes a normally distributed population. The population used in this analysis does not appear to be normal (see Printout 7) so the results may not be conclusive.) At the 5% significance level the data do not provide sufficient evidence to conclude that Flashtax software users have a higher rejection percentage than the population as a whole.

Printout 14 reports the sample mean of the rejection percentages for 1990 survey respondents who reported problems using the Lacerte software. The sample mean (9.7267) is less than the population mean (11.123).

```
MTB > ZTEST 11.123 17.753 C6;
SUBC> ALTE=1.

TEST OF MU = 11.123 VS MU G.T. 11.123
THE ASSUMED SIGMA = 17.8

              N      MEAN     STDEV   SE MEAN         Z     P VALUE
FLASHTXS      5    15.640     6.289     7.939      0.57        0.28
```

Printout 13. Hypothesis Test of Sample Mean and Population Mean.

```
MTB > MEAN C7
   MEAN     =       9.7267
```

Printout 14. Mean of Rejection Percentages for 1990 Survey Respondents Reporting Problems with Lacerte Software.

VIII. COMPARISON OF REJECTION PERCENTAGES FOR TRANSMITTERS

The rejection percentages for 1990 survey respondents who used third party transmitters were analyzed to determine whether the transmitter affected the rejection percentage. Four were considered, each having five or more users: Compucraft (Printout 15), CSC-TACS (Printout 16), Lacerte (Printout 17), and Flashtax (Printout 18). A hypothesis test was performed in each case to compare the sample mean with the population mean. (The Minitab ZTEST was used because it is appropriate for a sample with known standard deviation. The test assumes a normally distributed population.) At the 5% significance level only Flashtax had a higher rejection percentage than the

population. At the 10% significance level, however, Lacerte and CSC-TACS were also higher, while Compucraft was lower.

```
MTB > ZTEST 11.123 17.753 C8;
   SUBC> ALTE=-1.

TEST OF MU = 11.123 VS MU L.T. 11.123
THE ASSUMED SIGMA = 17.8

              N      MEAN     STDEV   SE MEAN         Z     P VALUE
COMPUCFT     19     5.042    11.103     4.073     -1.49       0.068
```

Printout 15. Hypothesis Test for 1990 Survey Respondents Using Compucraft Transmitter.

```
MTB > ZTEST 11.123 17.753 C9;
SUBC> ALTE=1.

TEST OF MU = 11.123 VS MU G.T. 11.123
THE ASSUMED SIGMA = 17.8

              N      MEAN     STDEV   SE MEAN         Z     P VALUE
CSC-TACS      5    21.360    21.679     7.939      1.29       0.099
```

Printout 16. Hypothesis Test for 1990 Survey Respondents Using CSC-TACS Transmitter.

```
MTB > ZTEST 11.123 17.753 C10;
SUBC> ALTE=1.

TEST OF MU = 11.123 VS MU G.T. 11.123
THE ASSUMED SIGMA = 17.8

              N      MEAN     STDEV   SE MEAN         Z     P VALUE
LACERTET      9    19.333    30.932     5.918      1.39       0.083
```

Printout 17. Rejection Percentages, Histogram and Hypothesis Test for 1990 Survey Respondents Using Lacerte Transmitter.

```
MTB > ZTEST 11.123 17.753 C11;
SUBC> ALTE=1.

TEST OF MU = 11.123 VS MU G.T. 11.123
THE ASSUMED SIGMA = 17.8

              N       MEAN     STDEV    SE MEAN         Z     P VALUE
FLASHTXT     12     20.667    15.390      5.125      1.86       0.031
```

Printout 18. Rejection Percentages, Histogram and Hypothesis Test for 1990 Survey Respondents Using Flashtax Transmitter.

LIST OF REFERENCES

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